PRACTICAL GUIDE TO DAIRYING

BY J. W. SMITH

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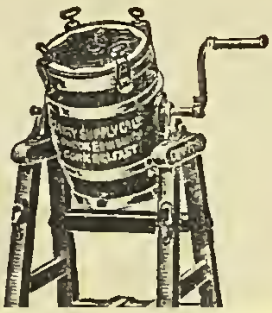

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PRACTICAL GUIDE TO DAIRYING.

PRACTICAL GUIDE TO DAIRYING.

BY

WILLIAM SMITH,

EDINBURGH.

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PREFACE.

THIS volume has been written to meet a continual flow of enquiries that come to me from various parts of the world in regard to the production of milk and the manufacture of dairy products. My long connection with the dairy trade has given me a comprehensive knowledge of all its branches, including the use of the most modern machinery. What I have written has been proved in my own experience, and I hope that the advice given will be useful wherever it may be read.

WM. SMITH.

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Illus. 1. FIRST-CLASS TYPE OF AN AYRSHIRE COW.

PRACTICAL GUIDE TO DAIRYING.

CHAPTER I.

HOW TO BREED COWS FOR COMMERCIAL DAIRY PURPOSES.

THERE is a great variety of pure and cross-bred cattle in the world, and every country and district clings to that breed which suits its climate and pasturage best. Therefore, it is difficult to describe how to breed the best universal cow. Taking Scotland, for instance, which is a very small country, in the North and West we have a breed of cattle set on strong short legs for climbing the hills, and clothed with a shaggy coat to protect them from the severity of the climate in which they live. But, while they are beautiful cattle, and when highly fed their carcases will bring the highest price in the market, they are not at all adapted for dairy purposes. Turning to the East of Scotland, where we have a richer soil and a somewhat drier and warmer climate, we have the Aberdeen-Angus, with a silky black skin, fine in the bone, of rapid development, and producing the best of beef; but no one would ever think of keeping a herd of Aberdeen-Angus cows for commercial dairy purposes. But when crossed with other breeds, and especially

when the value of the progeny is taken into consideration, there is no better cross in the world.

Coming down to the West of Scotland, where we have a larger rainfall, with a larger proportion of light soil and more permanent pasture, and where mixed farming is not so profitable, we have the far-famed Ayrshire breed, than which there is no cow that will produce the same amount of rich milk in the same climate at the same cost. But take her away from this environment, and put her in competition with other breeds and crosses for milk-producing and calf-rearing, and she fails to leave the same profit.

Passing over into the North of England, we enter the home of the Shorthorn, the queen of pure-bred cows, and no doubt as a pure breed of cattle the Shorthorn is the most useful throughout the world; but, for general dairy purposes, a blending of the Shorthorn with other milky and fleshy breeds, would give the best results for milk and beef combined. There are a great many other breeds of cattle, some of them giving very rich milk, such as the Jersey, Guernsey, the Kerry, the Devon, the Red-polled, the Holstein, the Buffalo, &c., all of which are fairly useful under certain conditions; but what is wanted for the dairy trade is a good all-round cow, that will produce a calf worth at any season 40s. when dropped, and grow into a useful butcher's beast; a cow producing 800 gallons of milk per annum, and bringing a good price in the fat market at the end of her milking career.

HOW TO BREED.

In giving our opinion as to the breeding of the best all-round dairy cow, we in no way deny that there are good milkers in most of the breeds. But from many years' experience as a breeder of dairy cattle, we have found that the most profitable cow for all-round dairy purposes—where the calves are either

Illus. 2. ABERDEEN-ANGUS BULL "BOWLER" (13208).
(As belonging to W. S. Ferguson, Esq., Pictstonhill, Perth.)

Illus. 3. FIRST CROSS COW BY AN ABERDEEN-ANGUS SIRE OUT OF AN AYRSHIRE COW.
(Bred by W. S. Ferguson, Esq., Pictstonhill.)

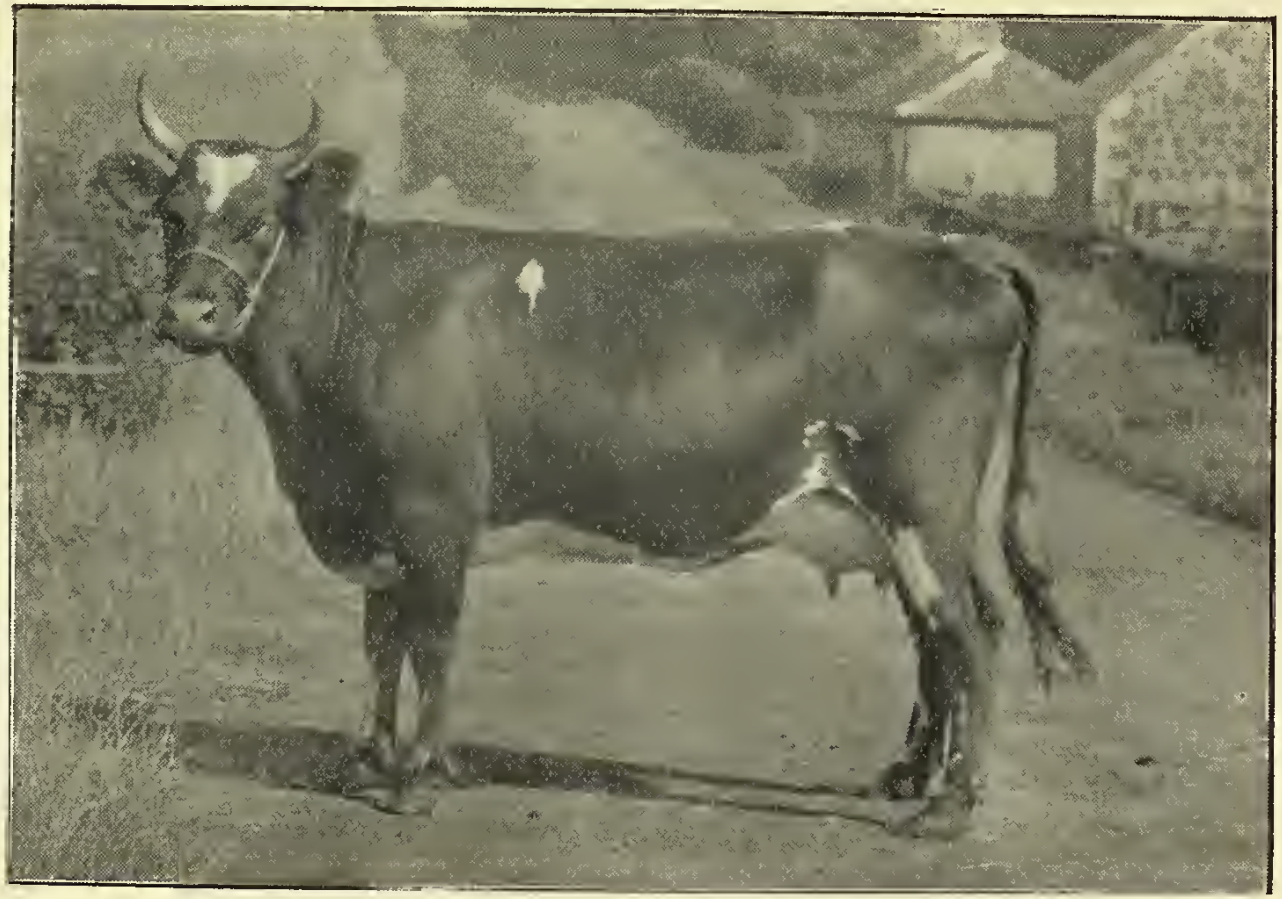
reared or sold for that purpose, the milk sold by volume, or for cheese or butter-making—is a cross-bred cow from the three blends of pure Ayrshire, Angus, and Shorthorn.

The process of blending these three breeds of cattle, in order to get the most profitable dairy cow, is open to difference of opinion, but no one who has practised the science of breeding cattle will deny the great importance of using only pure-bred bulls for crossing purposes. The loss and waste to the owners of stock through the use of cross-bred bulls at the present day is enormous. Few dairy farmers are able to keep several breeds of pure-bred cattle to produce cross cows for dairy trade purposes, but he can always buy a pure-bred bull, and it will pay many upland farmers to breed cross cows for general dairy purposes better than growing grain or feeding cattle or sheep.

The breeding of cows for city dairymen is a continual drain on the country, as these cows are of no more use for breeding purposes; and while it is a ready outlet for all the defective and doubtful cows, there is a great waste of breeding power in so many cows being killed before their time and filling the beef market with so much secondary meat, thus depressing the price of first-class butcher meat all over. City authorities are gradually putting dairies outside their boundaries, and in this way the milk trade will change into more natural lines, and the best cows allowed to bear calves throughout the best period of their lives. In breeding cross cows from the Ayrshire, Angus, and Shorthorn breeds, we prefer to begin with a pure Ayrshire cow, the characteristics of which are: wide forehead, neck and shoulders equally balanced, back short and straight, hook bones level, ribs well sprung, broad thighs, deep flanks, and short legs, with a well-balanced vessel and full-sized teats—a perfect type of the most useful animal in the bovine creation. It will be difficult to get many cows, with all these points

of perfection, to breed from; but in every case avoid small teats, with which so many of our Ayrshire stocks have been destroyed through the judging craze to get "tight" vessels—that is, vessels that cling to the belly more than hang between the legs. No one desires small teats, but they are the natural outcome of breeding for flat vessels. We begin by mating this cow to a pure-bred Aberdeen-Angus bull of good pedigree and size, such as you have in *illus. 2*, and we produce a first cross, such as you have in *illus. 3*, with well-set udder and teats, and evenly-balanced body. This is a good dairy cow in herself and a first-class breeder for future usefulness, and when mated to a Shorthorn bull will produce what we consider an ideal dairy farmer's cow. We have, in this cow, equal strains of the three best breeds of the bovine species, beginning with the smaller and gradually ascending to the larger animal. Doubtless some breeders will dispute the propriety of crossing first with an Angus bull, and would prefer the Shorthorn. One chief objection to this is, that when the Ayrshire comes to give birth to a bull calf by the Shorthorn she is often destroyed in the calving, and this loss is more than the profit gained in the larger first cross. It is true you may have a little more milk from the Shorthorn than the Angus cross, but this is more than counterbalanced in the early maturity value of the after-progeny for beef-producing purposes. You have a splendid type of a first cross between a pure-bred Ayrshire cow and a Shorthorn bull in *illus. 4*, which, when mated again to a Shorthorn, will produce an excellent dairy cow or stock for general feeding purposes in a moderate climate; but for general hardiness, milk, and first-class beef for a world-wide cow, I consider equal parts of Ayrshire, Angus and Shorthorn the most useful.

With all our commercial dairies stocked with this class of cows, and served with pure Angus bulls, you have a race of



Illus. 4. CROSS COW OUT OF A PURE AYRSHIRE COW, BY A PEDIGREED SHORTHORN BULL.

(Bred by, and belonging to Jas. Cameron, Esq., Gilston Mains, Largo, Fife. Photo by Lady Gilmour).

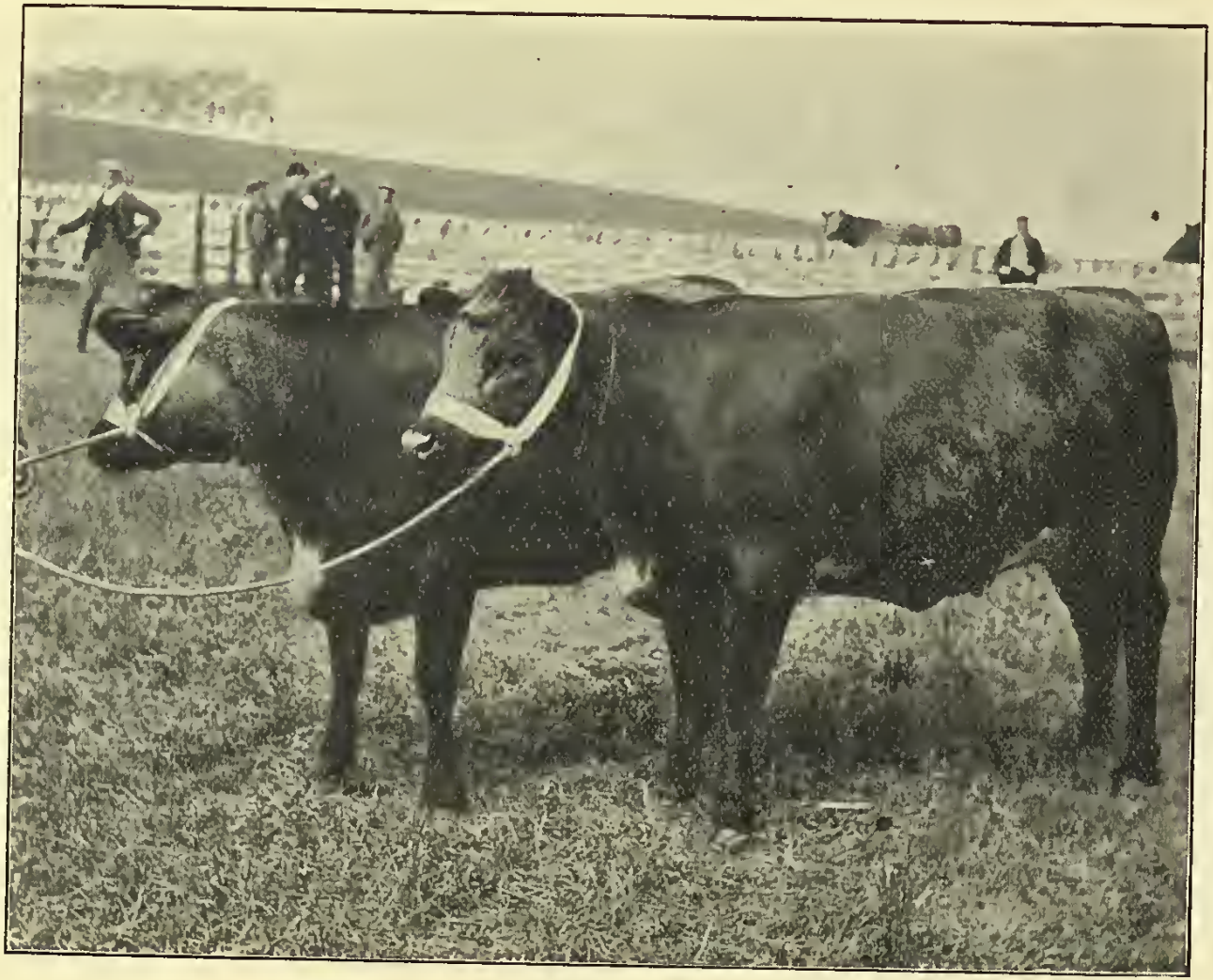
cattle for grazing and feeding that will lay on beef equal to best Scotch all the world over, such as you see in *illus. 5*, bred by Sir John Gilmour, Bart. But, some may say, Who is to breed this class of cattle?—the dairymen who produce the milk for the cities cannot do it. No; but those who farm land in outlying and upland districts may all do it, and find it to pay them better than any other system they can try.

The treatment of heifer calves, with a view to making them milch cows, scarcely comes within our province, unless to say that we have found, from experience, that you will get as good a milch cow from a calf that has been reared on the pail as from one that has been suckled by her dam, and at a great deal less cost. Heifers should not be put to service before they are 15 months old, and should be descended from dams whose record has been equal to 3·50 of butter fat and 750 gallons per annum. The stock bulls should also be descended from dams having the best record for quantity and quality of milk. The milking stock of all our counties, with a little more care, can easily be graded to 100 gallons per head more per annum, and one-half per cent. more butter fat than we have at present.

CHAPTER II.

HOW TO FEED COWS FOR GENERAL DAIRY PURPOSES.

THERE is a universal belief that you can regulate the richness of milk almost as you please, by giving a larger quantity of rich food to the cows, and a number of costly and elaborate experiments have been made in different countries to feed fat into milk; with few exceptions the experimenters have arrived at the same conclusions, viz., that the fat in milk depends more on the individuality and breeding of the cow, and can only be slightly altered by the feeding. Any increase in the fat in milk that arises from feeding rations rich in fat will only continue from four to fourteen days, after which the cow gradually falls back to her normal standard of fat, although the richer ration is continued, and the rise in the percentage of fat in milk, as well as the length of time it takes to come back to the normal standard, depends on the adaptability of the animal to accumulate flesh rather than milk; if she is readily inclined to flesh there will be little difference in the richness of the milk, and ten days will cover the period of variation; but, while neither rich nor excessive feeding will continue to maintain a higher standard, it must not be supposed that poor feeding will pay. A well-nourished body is essential to the prolonged production



Illus. 5. SAMPLE OF CROSS-BRED BUTCHERS' CATTLE.
(As belonging to Sir John Gilmour, Bart. of Montrave—on the lines advocated in first Chapter.)

of an abundant supply of milk, therefore it is sound practice to feed generously, the condition of the animal being a guide to the amount. The first condition of success in the production of milk is a healthy cow with highly developed organs of digestion and assimilation, capable of conforming the larger portion of the food into blood, which is passed on to a set of organs specially designed for converting it into milk.

The cow has a large stomach intended for a large quantity of moderately rich food, and not for a small quantity of concentrated food, hence the necessity of having bulk as well as fair quality; but while foods rich in fat will not maintain an increase in the fatty content in milk, some foods will increase the quantity of milk; and, to the dairyman who sells all his milk by volume, with little interest in the quality (so long as it meets the public standard of butter fat) or the longevity of his cow, it is a very important thing for him to know what food to give to produce the largest quantity of milk.

Milk is produced under a great variety of circumstances throughout the world, according to where it is produced and how it is to be used. For the last fifteen years city authorities have been removing cow-keepers from densely-populated localities and forcing them into the country; but in towns where there are a number of breweries and distilleries, where the bye-products of brewers' grains and dreg can be had fresh daily and without the cost of railway carriage, there is still a large number of continual stall-fed cows; the ordinary farmer will be surprised to know how these cows are fed and the milk they can produce.

In the first place, the man who carries on this line of dairying must be a thorough judge of milch cows, buying only animals of a strong constitution, with organs fully developed for yielding a large quantity of milk. The average life of cows under this treatment, from date of calving, is about

eight months. The average daily ration to produce three gallons daily for that period is:—

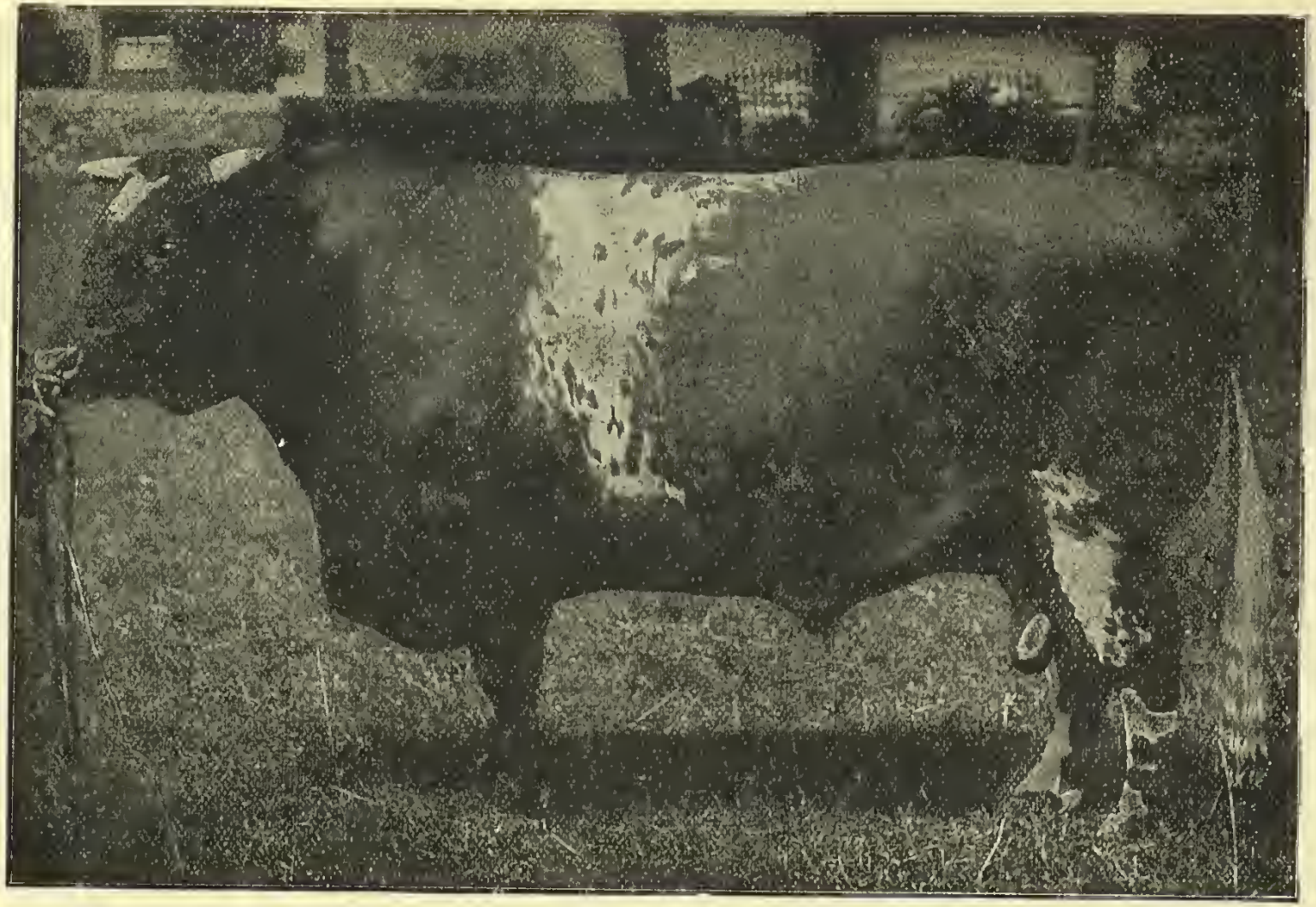
70 lbs. of brewers' grains, well salted.
4 ,, of treacle.
4 ,, of bean or pea meal.
10 ,, of hay.
40 ,, of turnips, mangles, grass or cabbages.

This works out at a cost of 11s. 6d. per week for food only; 21 gallons of milk weekly at 9d. per gallon equals 15s. 9d., leaving 4s. 3d. for risk, rent, labour, and reduction in value when sold to the butcher.

In many cases, the position of these dairies enables the producer to sell a proportion, and in some cases the whole, of his milk at 1s. 2d. to 1s. 4d. per gallon, without any extra expense for delivery; and, indeed, this class of dairying can only be carried on to profit where the milk is carried away by the consumer.

There is another system of producing milk, for public consumption, carried on all over the country—that of sending it to the cities and towns by road or rail. The introduction of refrigerators, whereby the milk is cooled down to water temperature immediately it is milked, enables the farmer to send his milk hundreds of miles by rail in good condition, thus largely equalising the value of land as well as milk all over the country, and reducing the price of milk to the consumer. The milk in this way is produced in more natural circumstances, and free from that forcing element carried on in cities.

The ration under this system varies according to rotation of husbandry in different parts of the country. In summer they are all very much alike when the cows are grazing in the fields, varying in cost from 6d. to 9d. per day. In cases where there is a contract for a given quantity of milk per day all the year



Illus. 6.

SHORTHORN BULL—"BRAVE ARCHER."

(As belonging to Sir John Gilmour, Bart. of Montrave. Photo by Lady Gilmour.)

round, and the producer bringing in fresh calvers to maintain the supply, in many countries he will have to stall-feed his cows for six months in the year. The following is a common ration for in-calf cows during this period, to produce say an average of two gallons daily :—

28 lbs. of brewers' grains, equal to 9 lbs. of dried grains.
2 „ of treacle.
4 „ of bean or pea meal.
2 „ of cotton cake.
10 „ of hay or sound oat-straw.
35 „ of turnips, mangles or cabbages.

The meal, cake, and treacle should have boiling water poured over them, and afterwards mixed with the draff or dried grains salted, and given in a sloppy condition. The cost of this ration will run about 1s. per day, making the cost of the milk 6d. per gallon for food during the stall-fed period, and 3d. per gallon for the grazing period.

The ration for cows kept entirely for the making of butter differs from the two previous systems, as the object here is not only to get the full quantity of butter fat the cow can give, but to have it free from any offensive odour or flavour, and firm in texture at all seasons of the year.

During the grazing period, and especially in the early part of that season, where the grass is rich and on highly cultivated land, the cows should only be allowed to gather part of their food, and have the remainder of a counteracting nature, say 4 lbs. daily cotton seed, cake, or meal. I have found from my experience in judging butter, both in Great Britain and Ireland, that a great many landed proprietors and large farmers are sorely disappointed when their butter is not in the prize list, and smaller producers from poorer districts carrying off the prizes, the reason being that their pastures are too rich in

themselves for producing the best butter, it is generally soft and greasy in texture.

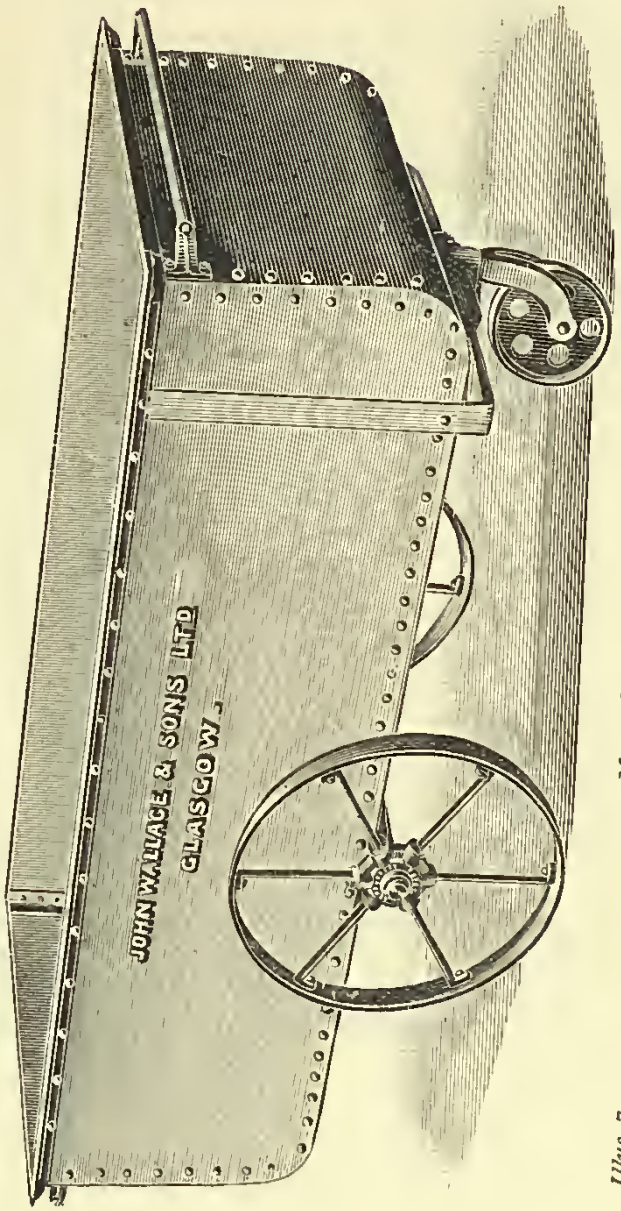
Any pasture that is capable of feeding cattle without the aid of other feeding stuffs is not so well adapted for making butter as permanent pasture on moderately poor land. The best stall-fed ration for first-class butter, from an average commercial cross-bred dairy cow in full milk, would be :—

7 lbs.	dried grains	Requiring five gallons of boiling water.
6 ,,	cotton seed meal	
2 ,,	crushed oats	
2 ,,	bean meal or pea meal	
2 ,,	wheat bran	
7 ,,	hay or sound oat-straw.	
28 ,,	cooked roots (mangles or turnips) or raw cabbages.	

The four first ingredients should be scalded with boiling water, and given in a sloppy condition. In no case should linseed meal or linseed cake be given to cows for butter-making; neither is it profitable to feed linseed cake to milch cows for any purpose except for the butcher.

The scalding or steaming of food is best done in a meat barrow. Where there is a steam boiler, a flexible steam-pipe with a nozzle is laid into the barrow with a wooden lid, and the steam turned on. As soon as the cooking is finished the lid is taken off, and, if need be, the barrow wheeled into the open air for cooling; when scalding only is required, the boiling water is poured over the food, and allowed to swell and cool as before, or cold water added as required.

The ration for feeding a dairy of stall-fed cows for cheese-making would be very much the same as for butter-making, but there are few stall-fed herds in the cheese-making system, as the best cheese is only made from the milk produced on pasture; and should there be a quantity of milk from this class of stock, it is more profitable to send it to town in the winter



Illus. 7. MEAT STEAMER AND COOLER.

season than to make it into cheese. City dairymen are always keen to buy from a winter supplier who can stop when required in the spring of the year.

In the case of supplying a butter factory, the rotation of croping should be regulated to provide a sufficient quantity of suitable food for winter keep, and the calving of the cows should be arranged to provide milk at the time when the butter is high in price. Calves dropped in the autumn are cheaper to rear, and ready for the butcher at an earlier period than those dropped in the spring of the year. Calves weaned in the spring of the year never loose their calf flesh, whereas those weaned in the autumn stand still all winter, as a rule, and only begin to thrive when they go to the grass next summer.

When oats are not worth more than 2s. per bushel in the market, they cannot be better used than fed to milch cows. Some feed them on the straw, while others prefer to thrash them and feed them crushed; the latter is certainly the most economical.

Cows should be fed according to their capacity, and in no case should food be left in their stalls.

Where cows are fed with roots, and there is no means of "pasteurising" the milk to take away the rooty flavour, the roots should be cooked. We recommend the use of cabbages as superior to turnips or mangles for producing milk for any purpose, and as a more profitable crop where the soil is suitable for growing them.

Illus. 8.

TWO COMMERCIAL AYRSHIRE COWS.

(As sold in the Edinburgh Market, 27th June 1900, for £44 the pair.)

CHAPTER III.

HOW TO BUILD TOWN AND COUNTRY DAIRIES.

THE importance of distributing milk to the public in a pure condition has been frequently under the consideration of the British Government, as well as the governments of other countries, and various Acts of Parliament and Orders of Council have been issued compelling all those who sell milk to have their dairies registered.

While registration is necessary to protect the public from the dangers of contaminated milk, arising from the short-sighted, greedy and untidy inclinations of some in the trade, still the large majority know that it is to their advantage in every way to have their dairies built and equipped far ahead of the government regulations, and it is very gratifying to see many dairy keepers vieing with each other who shall have the best dairy.

TOWN DAIRIES.

Town dairies in the past have been associated with the sale of other things than milk, and largely in the hands of single women and widows who lived in the back shops; in some cases even a family slept there with the beds only a few feet from the milk counter. Many a time when I have been serving milk to a shop, I have seen the mother rise from dressing her baby to take in her supply or serve a customer. Happily this kind of thing is done away with, but there still

remains the combination of selling other goods in the same shop with the milk, some of which are not in keeping with the trade, such as, cabbages, leeks, onions, carrots, and turnips, ham and bacon, the odour of which can be felt though unseen, not to mention paraffin oil and fish; such a combination is very detrimental to the trade.

In building a town dairy, no arrangement should be made for the sale of any goods other than milk, eggs, bread, aërated waters, confectionery, and the serving of tea and light refreshments. In selecting a site for a milk shop, unless when there is a decided advantage for "the run of the trade," the south or west side of the street should be chosen, preventing as much as possible the sun from striking in to the windows and door of the shop, for no method of shading will keep down the temperature to the same degree that you have on the cool side of the street.

For a retail trade without accommodation for serving refreshments, and capable of disposing 50 to 100 gallons daily, a shop 18 feet × 15 feet with a back shop or washing-house, entirely separate, of the same size, and lavatory accommodation separate from that, would be sufficient. The ventilation should be through and through, that is from the open air on one side to the other, and where the front and back shop occupy the width of the building, the ventilation should be brought across the back shop in an air-tight tube. There should be no entrance to any underground cellar from a milk shop.

The walls of the shop, from floor to ceiling, with sides of windows and window sill, should be covered with enamelled tiles with base course, dado, and cornice to taste—the ceiling of plaster, and the floor of tiles; the shelving of marble or slate, and the counter a marble table on bronzed legs without any front.

We recommend this kind of counter because we have found

from experience of many shops that the inside of a counter in 99 cases out of 100 is used as a receptacle for rubbish and a place for hiding unseemly things, and, in making provision for such a practice, the owner may lose all the benefit he expects to accrue from a handsomely-fitted shop, by breeding bacteria under the counter. It is true you lose the opportunity of decorating the front of the counter which is a leading feature in the shop attractions; still we think every sensible person will appreciate an open counter in a milk shop. The counter pans and all dishes for containing milk in a sale shop should be china; they are easily cleaned, having no seams for dirt to breed hurtful germs; cooler for keeping, more attractive than tin-ware, and impart no flavour to the milk.

Every milk shop should have an independent washing-house for cleaning all dishes used for the collecting and distribution of the milk — the floor concrete, and the walls cement, the ceiling of plaster with ample ventilation—built outside the main building if possible; but where used as a back shop, should be divided from the sale shop with a stone or brick wall. Every dairy washing-house should be provided with a steam boiler. There is no method of cleaning equal to scalding with live steam, and this can only be done where you have steam pressure. There is no doubt that large sums of money are lost in the dairy trade for want of a proper system of cleaning milk dishes. The general practice is to have a built-in boiler which gives you boiling water, but unless all the dishes are dropped into the boiler, they are never scalded, and how very few do this; only washing them in tepid water, thus spreading the fermentive germs over every dish in the place, and while they may look clean to the eye, they are swarming with bacteria all the time.

Small steam boilers can now be had to suit any dairy, made in the same way as larger boilers, only differing in size and

price, occupying less space than a built-in or portable boiler. One large enough to work at 30 lbs. pressure and supply steam for boiling water in a separate tank, scald all the dishes, and provide steam for driving a small turbine separator or turbine scalder, would only occupy a space of 2 feet in diameter by 3 feet 6 inches high; the flue would go into any ordinary house chimney. Many of them are now used where there are dwelling houses above them passed by both the Boiler Inspector and Fire Insurance Companies.

Illus. 9.
VERTICAL BOILER FOR SMALL DAIRIES.

Where the "pasteurising" or scalding of milk is carried on, a separate place should be provided apart from the washing-house, with concrete floor, cemented walls, and plaster ceiling, with ample ventilation with steam brought from the boiler to the scalder and turbine separator (if one is used) and the exhaust steam carried to the open air at the most convenient place or into the chimney.

The floors of all dairy premises, except sale shops, should be laid with at least a quarter of an inch of slope on each foot leading towards the most convenient outlet to the open air. No drains of any description should come inside dairy premises. All refuse should run outside and fall into a drain that is properly trapped. Nearly every dairy I visit I find pools of water on the floor, which is not only disageeable to the workers and offensive to the eye, but very detrimental to the quality of the products. Great care should be taken in the laying of the floor both as regards the quality of the material used, and that the water will run easily to the outlet, and leave no pools behind.

WATER SUPPLY.

The water supply in all town dairies should be laid on by gravitation from the public supply, with not less than an inch pipe from the main. Great loss is often sustained by the smallness of the pipes. When the work is in full swing, and especially when cooling scalded milk, it is most important to have a full supply of water. In many towns the water can be had at a certain rate per thousand gallons, and where this can be had it is better to pay for the quantity used, than to have the size of your pipe restricted according to the charge on the rental of the premises.

Private wells in towns are dangerous, and the water should not be used for dairy purposes, not even for washing dishes. We have known of several very serious cases arising from the use of contaminated water from town wells, and so long as you use the town supply you are as safe as the public themselves.

FARM DAIRIES.

The system of country dairying has been gradually undergoing a change for many years, but within the last three years

the change has been rapidly increasing, so much so, that at the present time, in Ireland especially, it is almost undergoing a revolution; therefore in dealing with the building of farm dairies I must look at the future more than the past.

The growing consumption of milk by the people of our great centres of population, the increased facilities for carrying milk by rail, and the establishment of creameries, is bringing about a change which is of great importance to dairy farmers.

There are three classes of farm dairies, viz.:

1. Those who cart or rail their milk to towns.
2. Those whose business lies entirely in butter or cheese.
3. Those who rear stock and sell what dairy products they have left.

The last two are very much alike in regard to the size and kind of buildings they require. Those who rail their milk to town, on the refrigerating system, require very little accommodation; the main thing for them is to have a good supply of cold water laid on by gravitation and a refrigerator that will cool the milk to the temperature of the water (which should always be under 60) as fast as it is milked; there is generally one milking each day kept twelve hours at the farm, unless when the milk is sent twice-a-day. The milk flows from the cooler into the railway cans, and is left there until train time.

Suppose you have a dairy of fifty cows yielding 150 gallons per day, the space required for that after it is cooled will be 9 feet square; but, in order to deal with a day's milk at home, we would recommend an outside dairy for refrigerating purposes, 15 feet by 12 feet, and an inner dairy with a brick division 15 feet by 10 feet, walls built of enamelled brick; if stone or concrete, cemented on the inside face; floor concrete, laid with a slope of $\frac{1}{4}$-inch to the foot toward a gutter along the side wall, with an opening in the wall at the most convenient place for the water to flow on to the grating of a drain; the

Illus. 10. DAIRY SHOP.

ceiling to be 9 feet high and plastered. Every dairy should have a ceiling and not open to the roof. A thatched roof gives better results, making the dairy cooler in summer and warmer in winter, than a slated roof. The windows should be to the north, and ventilated through and through from east to west where possible. Where the water is not laid on by gravitation to a dairy of this kind, there must be some system of pumping the water into a tank high enough to feed the refrigerator and capable of holding 200 gallons of water. The success of this system of dairying depends on thorough cooling.

There is a system of sending milk to towns by cart or rail, where the evening's milk is set in pans on shelves or on the floor, and the top taken off these pans in the morning by the hand and sent to the town dairyman in separate vessels. The one is neither cream nor sweet milk, and the other is neither, sweet milk nor skimmed, but generally known as "farmers' skimmed." This process is a very great deal of labour to the farmer, and requires a large dairy to conduct the operation. We do not think it necessary to give dimensions for a dairy of this kind, feeling sure they will not be required in the near future.

DAIRIES FOR BUTTER AND CHEESE-MAKING ONLY.

The buildings and furnishings of these dairies for individual farms are costly, requiring as much room and capital as would manufacture the produce of four or five farms if combined. In butter-making, the system of separating and ripening the cream by itself requires much less room than that of souring the whole milk in large cans or of setting the new milk in pans for hand skimming. We give dimensions for a fifty-cow dairy on the cream-separating system.

Every dairy farmer milking fifty cows should have a steam boiler as the most economical way of boiling water, scalding dairy dishes, steaming food for cattle, and providing heat by means of pipes to any part of the farm. A house, 10 feet square, is sufficient for the boiler and coal bunker, but it is generally more convenient to have the boiler in the washing-house with the coals outside. We recommend a boiler and washing-house 15 feet by 10 feet, a separating and churning-room 15 feet by 12 feet, and cream-ripening, milk-storing, and butter-room 15 feet by 10 feet—that is a range of buildings 33 feet long by 15 feet inside; the walls to be 9 feet high, built with white enamelled brick inside; if built of stone or ordinary brick, to be plastered with cement from floor to ceiling; the ceiling to be plastered and the floor of best concrete, laid with a slope of $\frac{1}{4}$-inch to the foot, and a channel along the side of the wall emptying itself on top of a grating outside. The drain to be fitted with a Buchan trap immediately below the channel outlet. The windows and doors should have a northern aspect. Where a water tank is used, it is most profitable to have it over the butter-room, which will be largely influenced by the temperature of the water in the tank.

In regard to buildings for a cheese-making room, for a similar number of cows, the same size and arrangements of buildings will be found suitable, with an additional cheese-storing room over the separating and churning room, where piping from the boiler can be taken to heat the cheese-room when required. A tank must be erected outside and thirty yards away from the dairy, if possible, for receiving the whey. If the dairy is not in a higher position than the tank, where the whey can run by gravitation, then a pump should be erected and driven with a jet of steam from the boiler, which will put the whey into the tank at the most convenient position. Care should be taken that no whey should get in

Illus. 11.

AYRSHIRE HEIFER.

(The Winner of the Derby at Ayr, April 1900.)

to any of the drains; better use it as a top-dressing than allow it to corrupt the drainage.

The rearing of calves and the making of butter—as the calves are able to take separated milk—is a simple method of dairying, and requires very little plant and space to conduct the operations. What milk is not to be used pure is taken to the separator straight from the cow, and the separated milk carried back and mixed with the pure milk, or given as it is at the natural temperature to the calves, and this is a decided advantage in having the milk always at the same temperature. The space required for a dairy of 50 to 100 cows, on this system, would be ample at 15 feet square for a separating and churning-house, with the boiler and washing-house outside, the specification in every way as before.

CHAPTER IV.

HOW TO BUY AND SELL MILK, WHOLESALE AND RETAIL.

COMMERCIAL articles are generally sold on a basis of quality, but how to buy or sell milk according to a standard of quality is not very well understood.

This is a question of vast importance to consumers of milk, especially in large cities. Hitherto the ordinary householder has had no ready means to determine the quality of the milk which he buys, and has been largely at the mercy of the seller. Quality in milk is, generally speaking, reckoned according to the proportion of solids. The average milk of commercial herds in Great Britain and Ireland is as follows:—

	Per cent.
Butter fat	3·50
Casein	4·00
Sugar	4·25
Albumin	0·50
Ash	0·75

Making a total of 13 per cent. solids, with 87 per cent. of water.

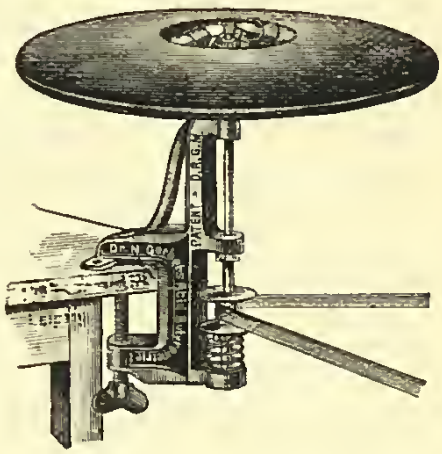
But it is possible for milk to be up to this standard, and yet be an objectionable article of food. Pure milk, in our opinion, should mean neither diluted with water nor adulterated with skimmed milk, or preservatives or other substances intended to deceive the buyer—clean, free from dirt or any offensive taint, taste, or smell; free from disease germs, and produced by healthy cows kept under the best sanitary conditions.

The question of fat, and solids not fat, is a very simple one,

and can now be determined by any ordinary person; but this does not prove to the consumer whether it is a safe article of food to give to his children. It may carry such germs as typhoid fever, scarletina, diphtheria, or, the most common of all, tuberculosis; bacteriologists have not yet discovered a ready method of detecting the presence of these germs in the milk, and the regulations established by law are too weak to guarantee this kind of purity to the consumer.

The law bearing on milk should reach the source from which the milk is taken; the housing of the cows, their food, and especially the water they drink, as well as that which is used for the cleaning of the utensils, examination of milkers, &c.

No doubt an extension of the law in this direction would cause considerable expense both to the landlords and tenant farmers, but they would be recouped by an enhanced price for the milk, and the nation saved that terrible death-rate of children, against which our best medical authorities have been crying out for years. But nothing short of a dairy commissioner, with a capable staff of assistants in each county, will bring this about; and the day is coming when every milk producer will have to submit to regular veterinary inspections of his cows, and report every death, sale, or purchase, in the interest of public health. But, while dealers in milk at present may be ignorant as to the condition of their milk regarding freedom from disease, there is no reason why they should not sell according to the total solids. The use of a Gerber tester and milk calculator, requiring half-an-hour's time and a penny-



Illus. 12.
Gerber Tester. Two Tests.

worth of acids daily, will accurately determine the fat, and solids not fat, in the milk of an average retail dairy. And the dairymen themselves must educate the public how to buy according to quality, and then the rich milk will bring a higher price; at present it is all very much alike.

Those who are able by force of steam to "pasteurise" their milk, under a system that is open to public inspection, will be able to give an additional guarantee that the milk they sell is free from all germs of disease, and consequently command a higher price. (*See* "How to 'Pasteurise,'" page 59.)

The manner of distributing milk is a very important factor in the spreading of disease. Dairymen's cans, as a rule, are scalded and well cleaned; but that which is carried by the public in their own vessels from shops, and the dishes into which dairymen empty the milk at private houses, are often very dirty. They may never be scalded in boiling water at all, and used for any purpose in the house. The milk is kept also in sleeping-rooms and closets without the least thought of danger. This class of culpable carelessness can only be overcome by elementary lessons in the school books, and dairymen issuing printed instructions to all their customers on the subject.

The system of receiving empty cans from infected houses should also receive the attention of the sanitary authorities; in no case should a dairyman's can be allowed inside an infected house. In several cases, we believe, where the spreading of an infectious disease has been confined to one dairy as the source of the milk supply, it has arisen in this way—by allowing the milk can to go into an infected house, and using the same can again and again from the delivery van without being scalded, spreading disease all round, and looking in vain for the cause at the source of supply.

Illus. 13. YEARLING BULL, "ECHADOR,"

(Bred by Sir Geo. Macpherson-Grant, of Ballindalloch, and bought by W. S. Ferguson, Esq., Pictstonhill, for 360 guineas at the Perth A.A. Sale of 1900.)

Milk should be served in cans with lids and stoppers, full, perfectly tight, preventing dust and air from getting in, or the milk splashing inside the can.

The houses of the men and women employed for the distribution of the milk should be also under the supervision of the sanitary authorities, and the employees paraded every morning for inspection before they begin their work.

In dealing with the sale of the milk of a special herd of cows, such as Jersey or Guernsey, where the butter fat may range from 4 to 6 per cent.—in order to obtain the high price this milk can secure—it is necessary to give a guarantee that each delivery will contain not less than say 13·5 per cent. of total solids, and this would be good value in any town at 1s. 6d. per gallon.

All milk should be sold according to imperial measure—4 gills = 1 pint, 2 pints = 1 quart, 4 quarts = 1 gallon. In the Midlands and South of England we have a barn gallon, which means nearly 2 gallons. In the North of England they call a $\frac{1}{2}$-pint a gill. In Edinburgh a pint is 4 gills, in Glasgow it is 16 gills, in Dundee it is 12 gills, and in Ireland there is also considerable variety. The system of giving a drop more than the measure is very deceptive, and should not be encouraged. No doubt the buyer likes to see an extra drop going into the dish, but they are generally deceived by slight of hand. The measure is used very smartly and kept off the level, so that it cannot contain the full quantity, and the extra drop is given without exceeding the measure intended.

The profits of the retail trade largely depend on being able to regulate the buying according to the daily sales. To have a fixed quantity bought equal to the maximum sales is very dangerous. A sudden change in the weather will reduce the

demand, and the overplus will be utilised at a loss. Therefore, it is wise not to be overbought, but to have some suppliers at will, even although a higher price has to be given. When surplus milk does begin to accumulate, the most profitable way to deal with it is to abstract the cream at once with a separator; and, if the cream is not saleable, sour it and make butter, disposing of the separated milk in the best way possible.

Where the dairy is large, and the surplus milk may run into hundreds of gallons daily, it may be necessary, to get a clearance without pouring the milk into the sewer, to make it into cheese, and a modern cheese vat capable of making 200 gallons should be kept. Where the milk is bought under 6d. per gallon, and in the hands of a trained cheese-maker, with the cheese sold in retail, no loss need be sustained with summer-made cheese.

The most advantageous system of distributing milk on the street is very ill to describe, different towns having different systems. In small towns and villages, where the housewives come out to the street to be served, the cart system going from door-to-door is the best. In larger towns, where the houses are built on the tenement system, and the housekeepers cannot appear on the street unless they are dressed, the milk must be carried upstairs—in many towns four storeys high; and this is a very costly process of delivery, and generally most profitably done from a shop in the tenement.

The system of delivering milk by perambulators, and boys to run the stairs, is common, but it has its difficulties in getting suitable men to undertake this class of work, and the expense in keeping them tidy and honest is very great.

Book-keeping is a very important thing in connection with the milk trade. The transactions are so small, and the

customers so numerous, entailing a great deal of clerical work.

The system of checking the sales should be as effective as possible, and every day squared off by itself; circulars sent monthly to all credit customers regarding the state of their account, and these circulars should be sent by the post, unknown to the salesmen. We submit specimens of a weekly book for credit customers, and a daily balance for a salesman or shop. In No. 1, the amount paid will be entered in the paid column whatever day it may be paid, and the balance carried forward at the end of the week. This sheet can be made wide enough to hold four weeks, and thereby save the labour of re-writing the names and addresses of the customers. In No. 2 specimen, the outstandings are taken from No. 1. Care should be taken that the returns are carefully measured and weighed, and that they are the same quality as taken out. All ready-money sales are accounted for in the cash.

No. 1.

SALESMAN or SHOP, No. . Week ending 19

Customer's Name and Address.	Brought forward.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Total.	Paid.	Carry forward.
	£ s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	£ s. d.	£ s. d.	£ s. d.
J. Jones, 8 Albert Street	1 2 2	1 2	1 2	1 2	1 2	1 2	1 2	3 0	1 12 2	1 2 2	0 10 0
P. King, 9 Eton Row . . .	0 5 0	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 8 6	0 8 6	..
R. Simons, 3 Braid Street	0 7 6	0 9	0 9	0 9	0 9	0 9	0 9	3 0	0 15 0	0 7 6	0 7 6

No. 2.

SALESMAN or SHOP, No. . Daily Balance, 19

Outstandings from last night .				£	:	:
— gallons sweet milk .	@				:	:
— „ skimmed milk .	@				:	:
— „ butter milk, .	@				:	:
— quarts of cream . .	@				:	:
— lbs. fresh butter . .	@				:	:
dozens eggs . .	@				:	:
			Total	£	:	:
Returns or stock .	£	:	:			
Cash . . .		:	:			
Outstandings . .		:	:			
				£	:	:
			Short	£	:	:
			Over	£	:	:

SAMPLE OF MILK CONTRACT.

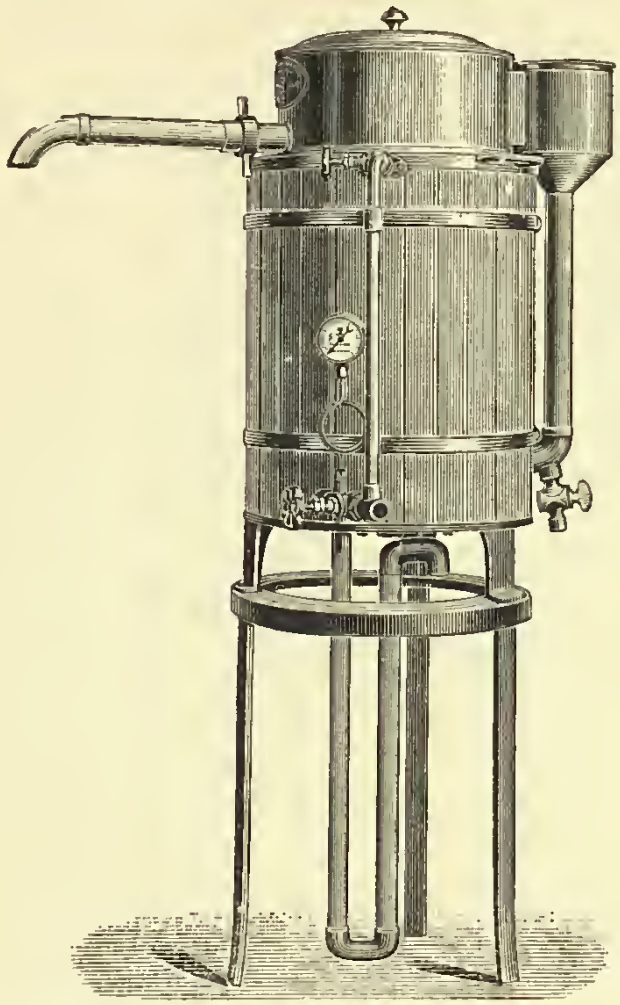
I hereby offer and agree to supply with pure sweet milk for one year from next; each consignment to contain not less than 3 per cent. of fat, and 8·50 per cent. of solids not fat, in quantities not less than gallons, or more than gallons daily, carriage paid, to Station; the milk to be paid monthly, at the rate of per gallon if the milk shall average 3·5 per cent. of butter fat for the month, as tested by the Gerber Butyrometer, or one farthing more per gallon for every ·25 per cent. of fat above or one farthing less per gallon for every ·25 per cent. of fat below this standard. And I agree to furnish with a certified copy of the Local Sanitary Inspector's Report regarding my dairy premises half-yearly, throughout the currency of this contract.

CHAPTER V.

HOW TO "PASTEURISE" MILK.

MILK, the moment it is drawn from the cow, becomes a source of attraction to bacteria of different kinds, which are floating in the atmosphere although unseen to the naked eye, and the warm milk provides an exceptionally favourable medium for the growth of these organisms. The most fruitful of these are the lactic ferment bacteria which convert the sugar of milk into lactic acid, which in itself, where properly regulated, is a helpful organism for the manufacture of dairy products, and in no way detrimental to the health of the consumer. But there are other organisms, such as the germs of typhoid, tuberculosis, diphtheria and scarlet fever—all dangerous diseases, and too frequently disseminated by milk. All these come from without, but there are cases where the milk is diseased before it leaves the cow's udder. It has been stated, on good authority, that there is a large proportion of the milk supplied to the cities of this country tainted with tuberculosis, and it is needless to say that such a state of matters is a source of danger to public health. Now this points to the importance of rendering these germs innocuous before the milk is consumed, and this can only be done by heating or "pasteurising" the milk. Milk contains butter fat in suspension, casein, sugar, albumen and mineral matter, and the nature of each of these constituents

can be changed with different treatment. In sterilising milk up to boiling point, the albumen coagulates whenever the temperature exceeds 186 deg., and the flavour of the milk is changed, and to many is rather disagreeable. This change



Illus. 14. LAVAL STEAM TURBINE "PASTEURISER."

The Shaft of the Stirrer goes right through the Turbine Wheel, which is driven by a jet of Steam direct from the Boiler; the Steam passes up into the Jacket and heats the Milk, which is flowing in by gravitation.

in flavour can be considerably modified by rapid cooling as soon as the milk has reached boiling point; but, in "pasteurising," there is no need for running the risk of going above 186 deg., all that is required is to touch 184, and all the dangerous

organisms have been killed without any change in the taste; and, with the exception of the germ of typhoid, all the others are killed at 160.

The constitution of an adult in good health defies these disease germs in many instances; but, with delicate children, the case is different. The best medical authorities are now laying stress on the extreme importance of "pasteurising" milk for infants, and already many of our hospitals, orphanages, and industrial schools have adopted the "pasteurising" of the milk, resulting in a reduction in the death-rate; and it must also lessen the expense in these institutions, not to mention the enjoyment and freedom from the anxiety of continual outbreaks of infectious diseases from the milk supply.

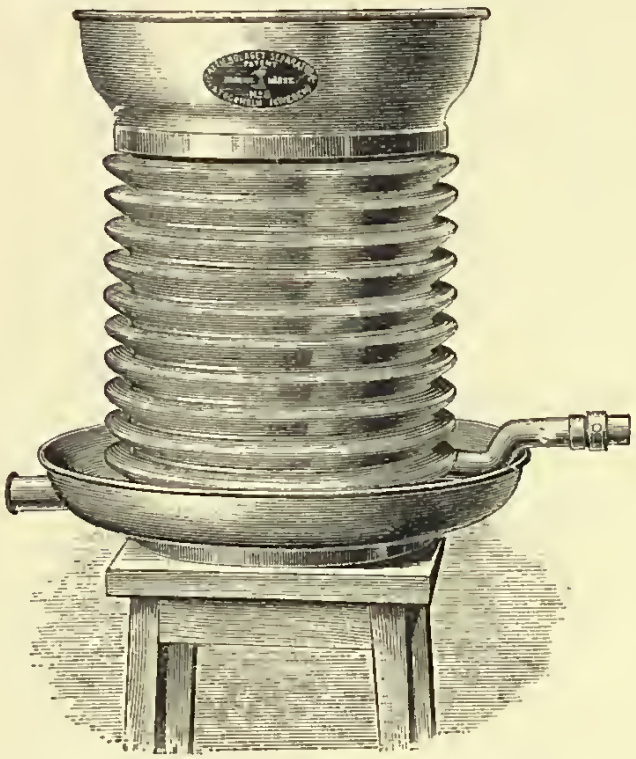
What is good for institutions in this respect is also good for families, and the time has come for all milk sellers to be ready to supply this class of milk to their customers. The process is not a complicated one, and the plant inexpensive; and, while they are prepared to supply milk free from disease germs, they are also prepared to save themselves loss through the milk going sour before they have time to dispose of it.

The process of "pasteurising" is very simple. The most common type of "pasteuriser," or scalder, is a copper cylinder, double jacketed all round. A steam turbine is fixed underneath, which drives a stirrer inside, the steam rising up into the jacket as it leaves the wheel, and thus stirring and heating the milk at the same time. The milk is fed from the outside by gravitation; and the stirrer, taking hold of the milk, makes a vortex in the centre of the copper, leaving a very thin wall of milk on the surface of the inner vessel, so that a very large quantity of milk can be heated in a short space of time, and without fear of burning. The operator, having full control of the steam and inflow of the milk, can regulate the temperature to any degree. It is advisable to have an intermediate tank

between the scalder and the cooler, so that the milk may stand for 20 minutes at the high temperature to ensure the destruction of all germ spores.

The cooling should then be done rapidly down to 60 deg., or lower, if possible. This milk should be distributed in cans with tight-fitting lids, reducing to a minimum the liability of fresh bacteria getting into the milk.

All who have to contend with the fluctuations of the dairy trade know what a boon it is to have a few gallons of good-keeping milk on hand ready for instant use, and this can only be obtained by the use of a "pasteuriser."



Illus. 15. LAVAL CYLINDRICAL COOLER,

With a Corrugated Cooling Surface on both the inner and outer faces of the Cylinder.

CHAPTER VI.

HOW TO STERILISE MILK.

MILK sterilising is a new process of treating milk in order to destroy all living germs, and preserve the milk sweet and palatable for an indefinite period.

Many people think that sterilising and pasteurising are the same thing, but they are entirely different. Pasteurising or scalding is more for checking the development of lactic acid and preserving the milk sweet for 24 to 26 hours longer, rendering the milk at the same time safer for immediate use than if it had not been pasteurised. If the pasteurised milk is allowed to stand open in an infected atmosphere, the disease germs will again take possession and multiply as fast as before; but sterilised milk is sealed in air-tight vessels under pressure of steam, and preserved from all kinds of contamination, and should keep as well in a heated chamber as in a cold store. Milk is sterilised in bottles, or in large cans, according to the requirements of the trade.

The bottling system is the most useful—being handy to pack in baskets for delivery, and containing such quantity as an ordinary household can consume right away—because, although perfectly sterile as long as it is in the bottle, and will keep longer fresh than ordinary milk after the bottle is opened, yet it is as liable as fresh milk to be contaminated so soon as it is exposed to the atmosphere.

The sterilising of milk can only be done with machinery specially prepared for the purpose, and every detail in the process must be carefully attended to, otherwise the milk is wasted.

The two best-known systems are the "Simplex" and "Sterilicon"—the one for small and the other for larger quantities, but both capable of sterilising in bottles or in bulk, and equally perfect in their operations.

The mode of operation is very much the same in both machines. The "Sterilicon" is the most suitable for large dairies; but we will confine our instruction mostly to the "Simplex" system.

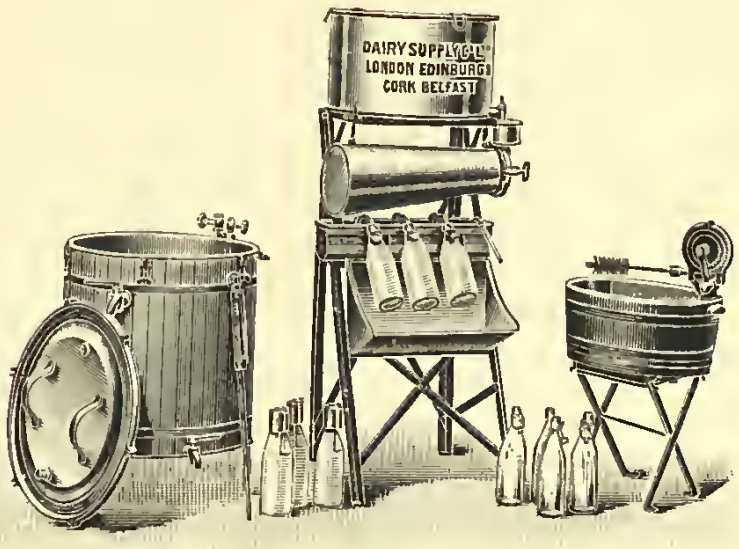
There are a few things, outside the heating of the milk, which require careful attention and help in the perfection of the process. Obtain the milk as soon as possible after milking, especially in the summer. If the milk is carried by road or rail, get the producer to cool it directly after milking to 60 deg. Fahr., and not to rise above 62 deg. until it is used; and, in order to prevent waste, all carried milk should be tested before commencing to sterilise. Take a well-mixed sample of the milk, add an equal portion of alcohol, and if the milk curdles or separates it is not fit for sterilisation. All the dishes, pails, bottles, and everything connected with the process must be steamed in a temperature of 212 deg. Fahr. prior to being used, and let the steam be direct from a clean boiler, and in no way connected with the exhaust pipes.

One most important thing is the filtering of the milk, and we have found from experience that the best process of filtering milk is to run it through a separator, using the special cleaning covers which can be procured for this purpose, not to run more than an hour without cleaning out the separator bowl; and, if you compare what is taken out of the separator with

what is left in the best-filtering process in existence, you will at once see the value of a separator in the purification of milk. 90 deg. Fahr. is the best temperature for filtering as well as for bottling, and no time should be lost between the filtering and the bottling, in order to get an equal sample of milk in each bottle, as the separator not only gives you the milk perfectly clean, but also perfectly mixed.

Where there is no separator the milk filter should be used, which is a horizontal can fitted with fine linen bags, through which the milk is pressed in an upward direction by gravitation, retaining the impurities more perfectly than if the milk were pressed downward.

The bottling machine shown in connection with the filter enables the operator to fill more bottles in the time, spill less milk, and with less risk of adding impurities than if it were done with the hand.



Illus. 16. THE "SIMPLEX" STERILISER:
A perfect, as well as a simple, Steriliser.

The "Simplex" is a strong, cylindrical, steel-tinned case, with steam-tight lid, and can be used with fire below or steam

brought straight in (preferable by steam), and has also a pipe for connection to the water supply, where convenient.

Suppose you have water and steam connected, and your bottles filled with filtered milk at 90 deg., begin by placing the bottles in circles on the bottom tray: the first row on the outside holds 24, the next 17, the next 11, and the centre 4—or, 56 pint bottles in all.

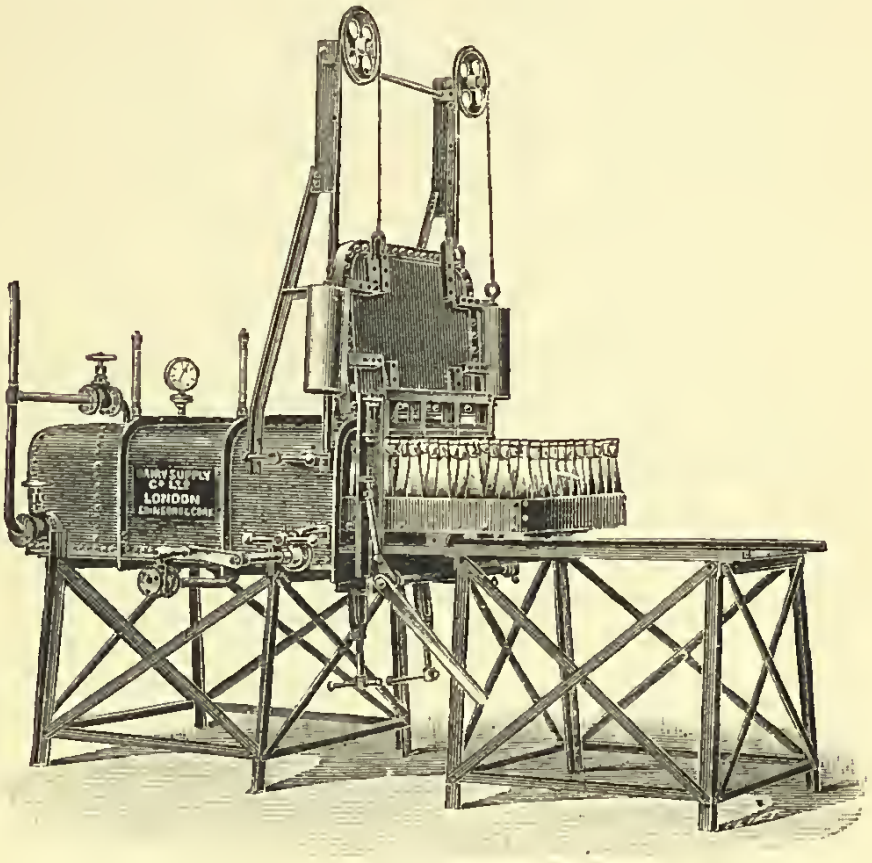
The lid is now screwed down and the steam turned on gently, so that the heat may not rise faster than to attain 212 deg. in 35 minutes; but it remains with the operator to decide at what temperature the bottles should be closed.

If the milk was fresh from the cow and to be used at home within a month, the heating may be stopped at 186 deg., and allowed to remain at that for 20 minutes, when the bottles are closed under the exclusion of atmospheric air. If the milk has not been fresh from the cow, or is to be kept for an indefinite time, or to be exported, it will be necessary to heat it a second time, after it has been cooled rapidly by letting water into the cylinder and allowing to stand 2 hours at 90 deg., to enable the unhatched spores to be incited to life; and then run it up again, as before, to 212 deg. Fahr. before closing the bottles. To avoid a slightly-boiled taste, cool the milk as rapidly as possible, taking care to have a fair amount of hot water in the cylinder when the cold water begins to flow in, to prevent the bottles breaking with too sudden a change of temperature.

Test each bottle as it comes out of the "Simplex" by holding the neck downwards with one hand, and tapping it on the bottom with the other; if it gives a sharp metallic sound, it shows there is a vacuum in the bottle, and it can be passed as perfect; if not, there is something wrong, and the milk should be used at once.

STERILISING IN THE "STERILICON."

The "Sterilicon" is a large, iron cylinder with a tight-fitting doorway, and a tray for the bottles, which is rolled in and out on wheels, and constructed with a special apparatus for closing the bottles while in the sterile vapour. (*See illustration.*)



Illus. 17. THE STERILICON:
For Sterilising Milk in large quantities.

The process of selecting the milk, filtering, and bottling, are the same as with the "Simplex." The bottles are arranged in straight lines on the tray, and when the doors are closed, the steam is turned on and the temperature raised gradually and the same rules observed as in the "Simplex."

STERILISING IN CANS WITH EITHER THE "SIMPLEX" OR THE "STERILICON."

Have the vessels well made and contracted at the neck to bottle size, so that the same stoppers can be used as in the bottles; this can be done by having a screwed lid, which can be taken off, for cleaning purposes. Select the milk and filter as before; fill the cans after they have been steamed for 20 minutes, at a temperature of 212 deg. Fahr. at least; place the filled cans in the "Simplex" or "Sterilicon," and turn on the steam, allowing the taps to blow off a little after the temperature has reached 150 deg. Fahr., allowing the heat to rise slower than with the bottles.

Milk sterilised in this way, and wanted only to keep for 10 days, need not be heated above 186 deg. Fahr., provided the stoppers are closed in the sterile vapour, and the milk cooled immediately it comes out of the cylinder.

When sterilised milk is to be used either from bottles or large cans, in order to have equal consistency, place the bottles or cans in a bath of water at 150 deg. for a few minutes before opening the stoppers.

The main feature in sterilising milk is perfect filtration and fresh milk.

CHAPTER VII.

HOW TO MAKE BUTTER IN LARGE AND SMALL DAIRIES.

THE making of good butter begins with the feeding of the cows; but, as we have already dealt with "How to Feed Cows for Dairy Purposes," we shall not touch on that subject again. Assuming that the cows are properly fed, and the milk is free from all taint of feeding, we shall deal with it first in the pan-setting system. The pans are sometimes called plates or basins. We assume that the milk has been milked from clean udders with clean hands, and into clean milking pails, and that no taint or odour has been communicated to it by untidy attendants, and that the setting pans have been scalded and aired before the milk is put into them.

The milk is strained into the pans as soon as possible after milking, and set on the floor or stone-shelving where the air is coldest and purest. The milk is allowed to sit 12 hours in summer, and 18 hours in winter before skimming. Four skimmings of cream may be put together in the cream jar and stirred every time, and allowed to stand 12 hours after the last cream is added before churning, in order that the ripening may be equal throughout The ripening of the cream—*i.e.*, the development of the lactic acid, both as to rapidity or slowness of its action, as well as the degree of acid in the cream before churning, is the main feature in butter-making under any process; but, in this system of pan-setting, it requires more attention and is worse to control than with whole milk or separated cream, because of the danger of too long exposure on

the plates before skimming, and the risk of mixing a tainted skimming with that which was good.

In a cold, damp dairy, without any artificial heat, the lactic ferment becomes dormant and produces bitterness in the cream, which no method of churning can rectify. In a dairy exposed to the sun, or where too high or fluctuating temperature goes on, the ferment is exposed to sudden changes, producing rancidity in the butter, which cannot be remedied in the churning. This accounts for the large proportion of bad butter we have in winter, because the cream is kept at too low a temperature, sometimes touching freezing-point. The ripening of the cream is best accomplished when the dairy is kept at from 60 to 65 deg. Fahr. In preparing the cream for the churn, the temperature may vary from 56 in summer to 62 in winter, and according to the temperature of the dairy in which it is churned, although in factories where very large quantities are dealt with it is advisable to churn at lower temperatures.

To raise or lower the temperature of cream for churning, immerse the cream jar in hot or cold water and stir until you get the proper degree. In mixing hot or cold water with the cream, unless the water has been "pasteurised," you run the risk of adding impurities to the butter, and also deteriorate the value of the butter-milk.

Illus. 18.
CHAMPION.

The best churn to use for small dairies is that made on the over-end principle, where the butter is made by air and concussion, and not by friction or beaters, which are more liable to injure the grain. The wide, open mouth enables it to be easily and thoroughly cleaned, admitting ready access to light and air. *(See illus.)*

When the churning process begins, the cream expands and gives off carbonic acid gas; the ventilator in the lid must be pressed down several times during the first three minutes' churning to allow this gas to escape, otherwise the compressed air is equal to the weight of the cream, and there will be little or no concussion, hindering the churning process and destroying the quality of the butter.

The speed to drive an over-end hand-power churn, to produce the best results, is 60 revolutions per minute, until the grains of butter begin to appear on the glass in the lid, when care must be taken to stop when the grains are about the size of shot or sago.

Overchurning runs the butter into lumps, when it is impossible to wash the butter-milk thoroughly out of it, thus leaving a quantity of acid, which will ultimately become rancid and spoil the butter.

Illus. 19.

The washing is best done in the churn with the butter in its granular condition, when the butter-milk is drawn off. The

first water should not be more than 7 deg. below the churning temperature, as washing with water below 48 deg. makes the butter paler in colour; and, when the purity of the water is doubtful, it should be heated to boiling-point, and cooled to its original temperature before washing the butter.

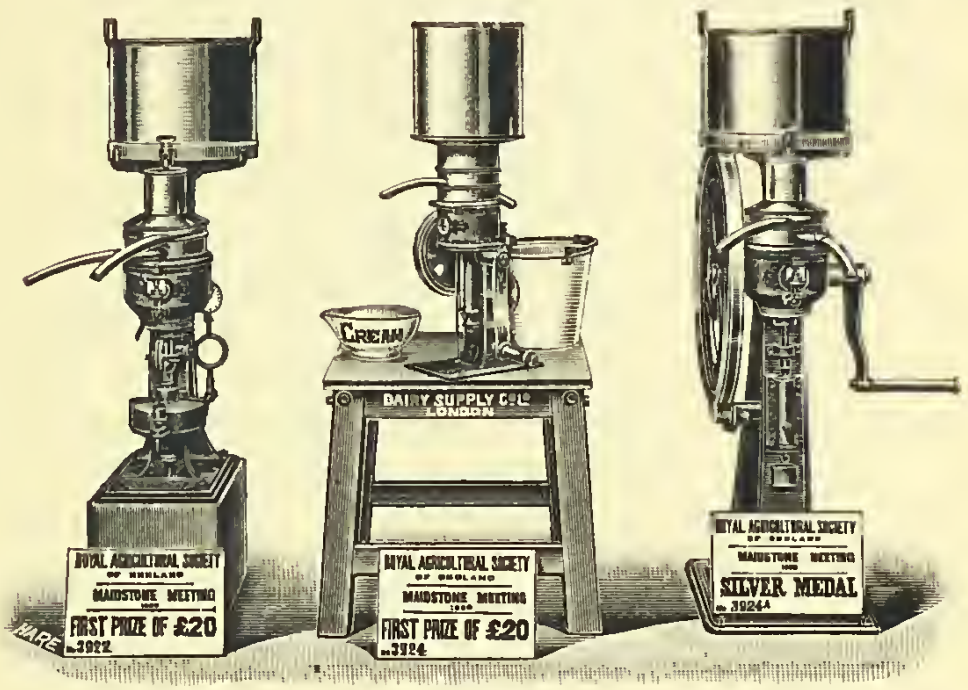
For salting, the butter need only be washed once; but, for saltless butter, it may be washed twice in the churn. The butter is removed while still in the grain to the butter-worker, and spread out gently to drain before beginning to press it. The butter-worker is a useful machine, but very often used rashly, destroying the grain without pressing out the moisture; care should be taken to do this work slowly, giving the moisture time to get away, and drying up every particle of water on the board between the workings. *(See illustration.)*

Pressing, not rubbing, is required in working butter. No one should touch the butter with the hands, either for washing or making-up.

To ascertain when the free moisture is all out of the butter, take a piece of butter between the Scotch-hands and press it gently, when any moisture remaining will appear, showing that it is needful to work a little more.

The style of making-up butter depends on the market, and varies in different places. Rolls are made up with butter-rollers made of hard wood about 9 in. square and $\frac{1}{2}$-in. thick, with a handle on the back. The oblong squares are made up with Scotch-hands or beaters, and is the swiftest both for making-up and packing. Round prints are made by placing the butter on the print and pressing it in a mould. Ornamental butter is made up by rolling the butter into thin sheets, and cutting it with a wooden knife into whatever shape required, for making flowers, fruit, &c., and put together in parts, as desired. In marketing butter, it should be rolled in the best vegetable parchment, which not only keeps it clean, but protects it from contamination.

In making butter under the whole-milk or "lappering" system, the whole milk is carefully strained when milked, and run over a cooler, and the temperature reduced to 65 deg. The whole milking is put into one dish and allowed to sit undisturbed, until the whole is coagulated, from top to bottom, with a rich velvety appearance, taking generally three days to ripen, in a temperature of 60 deg. In churning, this class of milk requires a higher temperature than gathered cream, owing to the globules of fat being farther apart, which take more violence and longer time to go together. Butter made in this way forms a very small



Illus. 20.

STEAM TURBINE. MAIDSTONE ROYAL. FARMERS' ALPHA.

portion of the world's supply, and is only carried on where the butter-milk brings a higher price than the skimmed or separated milk. The washing, working, and making-up is done in the same way as before. The most profitable system of butter-making is by separating the cream by the use of a cream separator. (*See illustration*).

We need hardly stop to describe the cream separator, as they are now nearly as common as reaping machines, and more useful, for while the reaper is only in use about ten days in the year, the separator is in use 365 days a year, and yields a profit in butter-making of 20% more than the pan-setting system, and 15% more than the whole-milk system. The principle involved in separating cream is the law of gravitation. The cream being lighter than the skimmed milk, and the two bodies revolving at the same rate of speed, the heaviest very soon relieves itself by seeking the outside of the circle.

The ordinary temperature for separating in farm dairies is 88 to 90 deg., but the latest improved Alpha Laval separator can now separate perfectly at any temperature above 80 deg. The quantity of cream to take off for churning is 15%. For butter-making, separated cream should be cooled over a refrigerator, as it passes from the separator, to at least 65 deg., or immerse the cream in cold water, stirring until it reaches this point; and, if there is not sufficient at one time for a churning, other creamings should be added at the same temperature and well stirred. The cream should be kept at this temperature for 48 hours, and no fresh cream added within 12 hours of churning. By adding a starter, the cream may be ripened in 24 hours, but it is preferable to allow 48 hours, in a temperature of 65 deg., where the atmosphere is pure. This class of cream should be churned at 56 in summer and 60 deg. in winter, and all the subsequent treatment as with the setting-pan system.

MAKING BUTTER IN LARGE DAIRIES.

When there is a sufficiency of milk to enable a churning to be done every day, or every alternate day, a separator should be in use; and, if possible, churn by steam, water, or electric power.

The milk should be treated as early as possible from the cow; if it has to be carried by road or rail, it should be cooled to 60 deg.

before it leaves the farm, and re-heated when it reaches the separator to 88 deg., and separated at the rate of 15 gallons of cream from 100 gallons of milk. This is moderately thin cream, but it gives the sufficient quantity of milk sugar to produce the necessary quantity of lactic acid in which to steep the butter fat, in order to give it that aroma so much desired, as well as increasing the keeping properties of the butter. The cream is cooled down as it leaves the separator to 65 deg., and run into a double jacketed cream-vat provided with water in the jacket, which can be regulated to any temperature by blowing steam into the water, thus securing an even temperature at all seasons of the year, and a uniform quality of butter every day. It is necessary, to carry out this system properly, to have three vats, so that the cream may be kept 48 hours before churning. The churning temperature under this system can be done at 58 deg. all the year round, and the butter treated after it leaves the churn in every way the same as in small dairies, only with a larger butter-worker.

HOW TO SALT BUTTER.

The most important thing, in the salting of butter, is the quality and condition of the salt. The salt should be dry, finely ground, free from lime, and not less than 98 per cent. soluble. While some salts may be quite suitable for ordinary household purposes, they are altogether unsuitable for butter. Salt absorbs moisture from the atmosphere, and when it is exposed in a damp room, or to the open air, it becomes partially soluble; when used for butter in this condition, it produces streakiness in the first place, and latterly blueness and rancidity. That portion affected by the dry salt improves in colour, and that portion affected by damp or partially dissolved salt, deteriorates in colour; and the magnesia generated by the action of the damp atmosphere on the salt,

is the cause of the rancidity. There is no doubt that thousands of pounds are lost annually to the butter trade by the use of bad salt. The writer had once the misfortune to salt 15 cwt. of butter, worth 1s. 1d. per lb., with inferior salt, which was sold 8 weeks after at 6d. per lb.; the saving on the price of the salt, as compared with pure dairy salt, was 1s 6d.; the loss on the butter was £47, 16s. 8d. This shows the importance of using pure dry salt, and the necessity of keeping the salt in a perfectly dry room, and in clean bags. Whenever the salt begins to show moisture on the outside of the sack, a portion is already unfit for salting butter, and the same applies to all salt that has been exposed to a damp atmosphere for over 24 hours. The quantity of pure salt to be used, varies according to the time the butter has to be kept, and the season of year when it is salted. For powdered butter, that is to be consumed at once, ½ oz.; for cured butter to be consumed in 8 weeks, ¾ oz.; and for full-cured butter, to be kept more than 2 months, 1 oz. to the lb.; or, where butter is made in large quantities, 3, 4½ and 6 per cent. of salt, and in addition to this some add ½ lb. of saltpetre to the cwt. of butter.

Butter salted during the months of April and May, owing to the change of feeding from fodder to grass, should have a ½ per cent. more salt, and no attempt should be made to keep that class of butter beyond 8 weeks.

To prepare butter for salting, proceed in the same manner as for fresh butter until drawing off the butter-milk, when the second washing-water should be brined with 2 lbs. of salt to the gallon of water, and the butter allowed to remain in this water for 15 minutes, after which it should be removed to the butter-worker, and gently pressed twice under the roller before the salt is added, otherwise, the excessive moisture carries away too much of the salt; press it twice again under the worker, while the salt is being added, roll it up firmly in a lump and

cover it up from the air for several hours (over night is the best), and work very gently again, giving the moisture plenty of time to get away. Pack right away from the butter-worker, using a wooden packer for pressing into the crock or cask; pour off any moisture that may arise on the top of the butter during the packing. In this way the butter is practically worked three times before the packing is finished, therefore care must be taken not to work it much in the earlier stages, otherwise it will be in a very greasy condition before the curing is completed. In many places, where the water used for washing the butter before salting may be liable to convey contamination, the remedy is to scald the water up to boiling point, and cool it down again to the temperature required for washing; those who have the means for cooling the boiling water to 52 deg. Fahr., will find it to pay them very well to "pasteurise" all water used in the washing of butter.

The "pasteurising" of milk or cream, while it is perfectly fresh, up to 184 deg. will evaporate that "turnipy" flavour so detrimental to winter-made butter where the cows are largely fed on raw turnips, but the milk or cream must be cooled at once to at least 65 deg. and the ripening carried on as before.

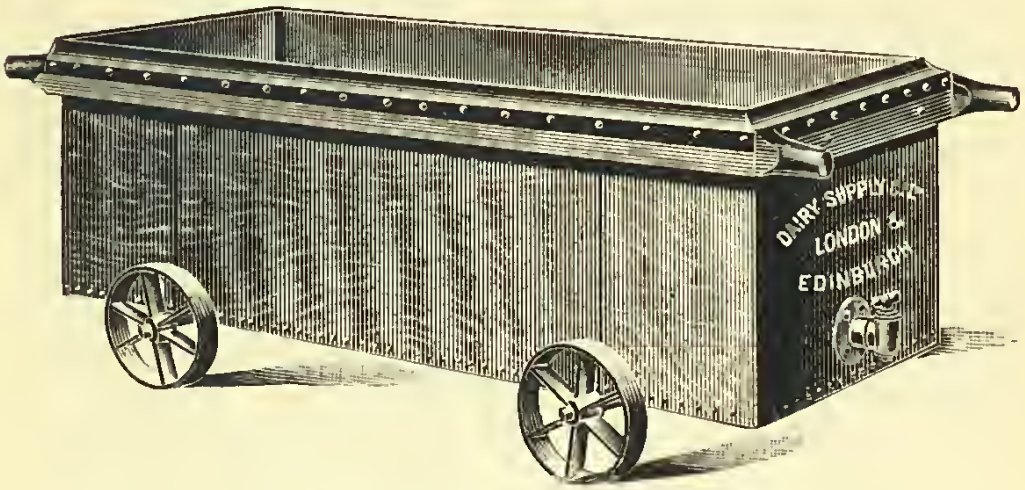
CHAPTER VIII.

HOW TO MAKE CHEESE IN LARGE AND SMALL DAIRIES.

IN cheese-making, as in butter-making, many makers use no thermometers, the temperature throughout being a matter of guess-work. There is no testing the condition of the milk before the rennet is added, or the preparation and strength of the rennet; and the exact proportion to the quantity of milk is still, in many cases, prepared and applied haphazard.

The cleaning and ventilating of byres, and especially the cleaning of the udders and teats of the cows and the hands of the milkers, where impurities get into the fountain-head, is too much a matter of indifference; and there is no doubt that from this source large quantities of milk have been, and are being, ruined for the making of fine cheese, before it reaches the cheese-vat. It is only by constant supervision that this can be prevented. In many cases in the past, the dairies where the cheese was made, and especially the curing-rooms, were badly suited for the making and ripening of first-class cheese. Now, the walls and floors of the dairy must be cemented or tiled. No open joints must be left, or large holes for bacteria to breed in, and all the surroundings kept scrupulously clean and used for dairy purposes only. The curing-rooms are now lined with wood, and fitted with self-acting turning racks; the heating done by piping, which gives an equal distribution

of heat all over the room, instead of stoves which always give more heat in one part than another. In the past, the cheese vats had no double jacket, and the milk and whey were heated over a fire, or in a boiler which caused more work and more liability to make mistakes than with the modern double-jacketed vat, where steam or hot water can be introduced and controlled to a nicety. In the past, the curd was broken and stirred with the hands, now it is cut with vertical and horizontal knives and stirred with a breaker. In this way the curd is more evenly cut, and all the particles equally exposed to heat. In the past, the cheese had to wait on the maker, but now the maker waits on the cheese; everything must be done at the proper time, a few minutes out or in. One degree wrong in temperature, at certain stages, will alter the condition of the cheese and spoil the quality of the whole lot.



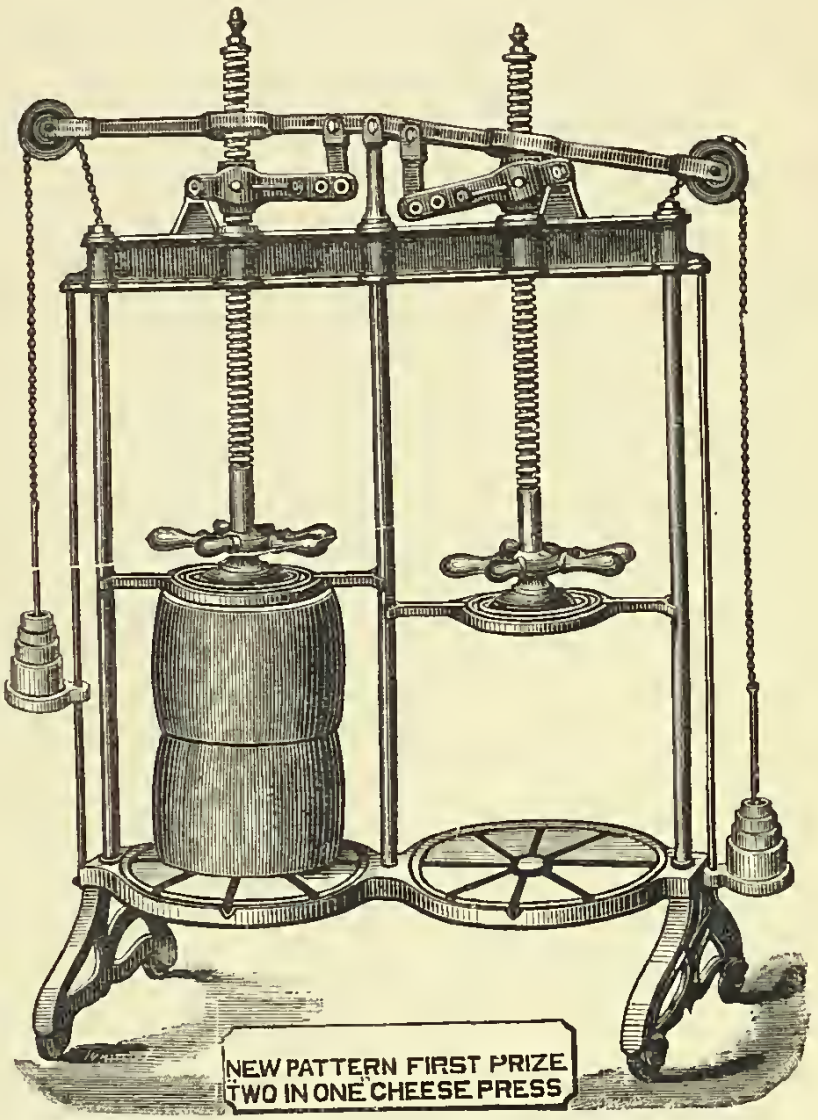
Illus. 21. DOUBLE-JACKETED CHEESE VAT ON WHEELS.

The first essential in the making of fine cheese is pure, sweet milk of good quality, and, given this, we proceed to make a Cheddar on modern principles. The evening's milk is strained into the vat, and if the weather is hot it is cooled down, so as to be about 64 deg. Fahr. in the morning, stirring occasionally

during the evening. In the morning the cream is skimmed off and heated to 90 deg. This is done by placing the can of cream in hot water, usually the open boiler; then the cream and the morning's milk are strained into the vat together. The careful cheese-maker will then test the milk for ripeness. This is done by taking 4 oz. of milk at renneting temperature, and to this we add 1 drachm of Hansen's extract of rennet. If the milk coagulates sufficiently to catch on the finger, in from 20 to 24 seconds, we consider it ready for adding the rennet; if not, warm a little longer until it responds to the test, and then add the rennet; $2\frac{1}{2}$ oz. of Hansen's extract to 100 gallons of milk, at a temperature of 84 deg. in spring and autumn, and 82 deg. in summer. This will coagulate the milk in from 45 to 60 minutes. After the rennet has been added, stir for 10 minutes, to prevent the cream from rising, then cover until the coagulation is complete. The covering will prevent the temperature from falling too rapidly, and also keep out dust. When the curd breaks clean on the finger, and a little green whey gathers in the break, the curd is ready to cut. First cut with the vertical knife, and then with the horizontal, using both, lengthwise and crosswise. This should be done very gently, as rough handling at this stage will cause loss of fat. The sides and bottom of the vat should then be cleaned with the hands to make sure that no curd is adhering to the vat, then allow the curd to settle for 10 minutes. If it is soft, allow 15 minutes; then use the breaker until the curd is the size of peas. This should occupy from 45 to 60 minutes. We now commence to scald, operating with a double-jacketed steam vat. The heat should be raised at the rate of 1 degree in 4 minutes, until we reach 100 or 102, this being the required temperature. If we heat with water, in a double-jacketed vat, we first raise it to 90 deg.; stir 15 minutes, then to 95 deg.; stir 15 minutes more, and then raise to 100 deg. If the cheese is made in a

single vat, we allow the curd to settle for 10 minutes, then draw off sufficient whey at two different times, and heat to not more than 130 deg. The first heating will raise the temperature of the bulk to 90 deg., and the second to 100 deg., but the results in this way are not so satisfactory as with steam or water. Stir till the curd becomes shotty, hard, sinks quickly, and will attenuate $\frac{1}{4}$-inch to an iron heated to a black heat. The curd is then allowed to settle for 15 minutes, after which it is cut up the centre and rolled to the end of the vat, when the rack and weights are placed on. The whey is then drawn off, the curd is cut in square pieces and spread on the bottom of the vat. Afterwards it is piled in a square block, all crumbs swept up, covered with a cloth, the rack and weights placed on, and allowed to remain for 10 minutes. It is then cut into bricks and removed to the curd-sink or cooler, covered and weighted, and allowed to remain 20 minutes. The curd is then turned, and this process of turning, covering, and weighting continued until the curd presents a rich, dry, solid appearance, and distinctly acid to taste and smell, and attenuates $1\frac{1}{2}$-inches to hot iron. It is then put through the curd-mill, weighed and salted at the rate of 1 lb. of salt to 50 lb. of curd, using the finest dairy salt, 98 per cent. soluble. The temperature at this stage should not be above 80 deg., and it should then be stirred in the curd-sink till cool enough for filling into the chesset and putting into cheese-press. The temperature should be from 70 deg. to 75 deg., not less than 70 deg. Great care should be taken not to put on too much pressure at first, reaching 10 cwt. in the first two hours, and allowing this to remain all night (too much pressure at first will cause loss of fat, and make a dry cheese). Next morning, when turning the cheese, immerse it for one minute in water at 120 deg., put on fresh cloth, and give 10 cwt. pressure for first two hours, then 15 cwt. till next morning. Next morning

it should be greased and capped at one end, and one ton pressure applied. On the fourth day it should be neatly bandaged and put in press with one ton pressure till afternoon,



Illus. 22. DOUBLE CHEESE PRESS.

when it should be taken to the curing-room, the temperature of which should be from 65 deg. to 70 deg., and turned daily for six weeks, and every other day till twelve weeks. In curing, the cheese will diminish in weight about 7 per cent.

These details show that great watchfulness is required in the making of cheese. The time and labour occupied in making 50 gallons is equal to making 100 gallons—that is, the expense connected with a 25-cow dairy is equal to the expense of a 50-cow dairy in the making of cheese. The following is the actual time taken by the writer to make one day's milk (in August) into cheese—beginning at 8 a.m. and finishing at 5 p.m.:—The time we arrived at the different stages were—rennet added 8.53; curd cut 9.50; began to stir at 10.10; began to scald at 10.57, temperature 80 deg.; scalded to 102 deg., at 12.3; finished stirring at 1.3; rack and weights placed on curd at 1.10; curd cut at 1.25; whey drawn off at 1.37; placed in curd-cooler at 1.52; turned at 2.25; turned again at 2.55; cut in smaller pieces at 3.25; turned at 4.5; milled and put in cheese-press at 4.35; vat, curd-cooler, curd-mill, and all the accessories cleaned at 5 p.m. This last item—viz., the cleaning up, is a very important part of cheese-making.

With regard to the use of "starters," such as sour whey, lactic ferment, pure cultures, &c. &c., most cheese-makers use sour whey when the milk is slow to move in the morning, and many use it with considerable success throughout the whole season. The use of lactic ferment and pure culture is only another means to the same end, with this advantage, that instead of working with the same breed of bacteria in your sour whey all the season, which are liable to degenerate and allow the wrong kind to predominate, you can have a pure breed once a fortnight. The theory is that this pure breed are strong enough to subdue all the bad bacteria that are imported by impure water, air, or dirt, and defying them to impart any bad flavour to the cheese. This pure culture theory, however, is only in the bud. Time will, no doubt, demonstrate what it can do in the way of preventing

discoloration, and at the same time improve the general quality of cheese.

To those who make cheese from the milk of one or two cows, or from surplus milk at certain seasons of the year, and who cannot afford the expense of a complete set of modern cheese plant, we would advise—instead of making curd every day, and keeping it over to mix with several days—in order to make a fair-sized cheese, to cool two milkings by immersing the warm milk in running water, and keep at that temperature until the third milking is ready, when the cream must be skimmed from the two previous milkings heated to 90 deg., and the cream and the third milking added together; then proceed as nearly as possible on the lines we have indicated for making cheese in a single vat, always using Hansen's extract of rennet, the strength of which can be relied on and the price moderate, instead of running the risk of spoiling the cheese by the use of rennet made from a calf's stomach.

Each time a new vell is bought from a vendor, or cured at home, the strength is ascertained at the cost of one or two cheeses, which are spoilt by adding too much or too little rennet, the maker not knowing the strength until it has been tried. For this reason, therefore, we recommend the use of rennet that can be relied on.

The Dunlop cheese derives its name from a town of the same name in Ayrshire, and the make is still largely confined to that county. To make a Dunlop cheese, begin by renneting at an earlier stage, taking the same quantity of milk and rennet as in the Cheddar acid test, allow 26 to 30 seconds for coagulation, and follow the same system as in the Cheddar, only scalding to 95 instead of 100. Confine the size of the cheese to 60 lbs. or under, press more gently, and ripen in a colder room, beginning with less acid in the milk, and

working and curing at a lower temperature, thus retaining more moisture, and, consequently, softer texture. The price is from 2s. to 4s. less per cwt. than for Cheddar, but this will be equalised by the additional moisture in the cheese. The Dunlop is made without colour. It is plain-flavoured cheese, and mostly sold in Glasgow, where there is a ready market for it.

The difference between skimmed and full-milk cheese in making is to work the skimmed at a lower temperature, and ripen in a colder room.

At the creameries, where large quantities of separated milk is being handled, they make a mixed cheese, commonly called "filled cheese." These are made by adding animal or vegetable fat to the skimmed milk by means of an emulsor. This system can only be carried on where there is steam and large premises. This kind of cheese was sold for some time without any distinctive name, but recent decisions in the Law Courts obliged the manufacturers and retailers to sell them as oilene cheese, reducing the price; many creameries are now returning the separated milk to the farmers, who can more profitably utilise it in the rearing of calves and feeding pigs.

There is a growing desire for cream cheese. The Dairy Institutes teach their pupils how to make this class of cheese. They are made from sweet cream, and sell readily at 1d. per oz., Gervais, Pont L. Evêque, Gorgonzola, Port de Salut, Coulommier, and other soft cheeses.

CREAM CHEESE.

Use only fresh, thick cream from the shallow pans, or the separator, but not from Jersey creamers. Cool down to 60 deg., and then hang up to drain in a cold, draughty place, in a fine linen cloth. If the weather is hot, a little preservative should be added previous to setting or separating. Let the

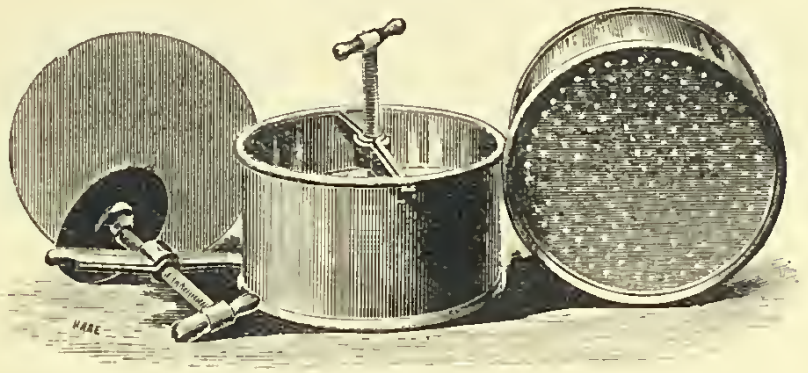
cream hang 12 hours to drain, then scrape down the sides of the cloth and let it drain again from 6 to 12 hours; at the expiration of this time, change the thickened cream into a more open cloth of strong linen; change these cloths every 6 to 8 hours, until the cream is thick enough to mould. The secret of making good cream cheese is to have the cream thick, perfectly sweet, and to use only sweet, clean cloths, changing them often. Make up in moulds of from 5 to 10 ozs., and, for sale, wrap in butter muslin and pack in round cardboard boxes.

GERVAIS CHEESE.

This is a cheese made of two-thirds new milk and one-third cream. The milk and cream should be of one meal if possible, and the cream separated; care should be taken to have both quite fresh. The mixture is set at a temperature of 65 deg. Fahr., a little lower in summer and a little higher in winter. Mix the two half-an-hour before adding rennet, and stir carefully.

The best cheeses are made of a 24-hours' curd, which is obtained by adding 1 drop of Hansen's rennet to each quart of the mixture, mixing the rennet with a little water. Stir occasionally till the mixture coagulates. If a quicker cheese is required, 2 drops of the above rennet can be added per quart, and the coagulation will be firm enough in 8 to 12 hours; but a larger proportion of cream must be used to prevent grittiness. A little whey must collect on the top of the curd before ladling out. Use hackaback or crash cloths for draining. Ladle the curd out with a round iron bowl, carefully, and in fine slices, being careful not to crush or break. The cloth, which should be wrung out of hot water, with its contents, is hung up to drain. Three quarts is sufficient to tie in one cloth. Open out once or twice while draining, and scrape

down the sides to insure uniformity; and, when the curd is solid, it is slightly salted and then put into moulds, which are lined with special white blot-paper. In these moulds the cheese ought to remain 3 or 4 hours to drain and settle, and to allow the paper to adhere properly (when the cheeses are made in larger sizes, special shapes are provided, such as the



Illus. 23. GLEED PRESS.

Gleed press—*see illustration;* these shapes are lined with fine butter muslin). If the curd is gritty, press through a fine cheese-cloth before moulding. Neglect to stir the mixture when setting, causes a settling of milk in the bottom of the bowl; this should not be mixed with the other, or it will cause grittiness. A yellow pine or buck board and straw mat are necessary on which to place the moulds while draining. The cheese should be drained in a room not higher than 60 deg. Fahr.

In conclusion, let me answer the question we hear so often—"Why are there so many bad-flavoured cheeses in the market, and what is the cause?" Much of this bad flavour is caused by a general want of cleanliness, by using faulty utensils where the joints are continually full of old curd, in a state of decomposition, which taints every cheese, producing changes for the worse throughout the whole ripening process.

Bad rennet, bad annatto, newly-calved cow's milk, or a chill in the curing-room, all produce their own changes, and are causes of bad-flavoured cheese. A sour cheese is produced by a soft, spongy curd that has been chilled before it reaches the cheese-press. It will thus be seen that the making of soft, meaty, mild-flavoured cheese, depends on close attention to every detail—from the milking to the day the cheese passes into the hands of the merchant.

CHAPTER IX.

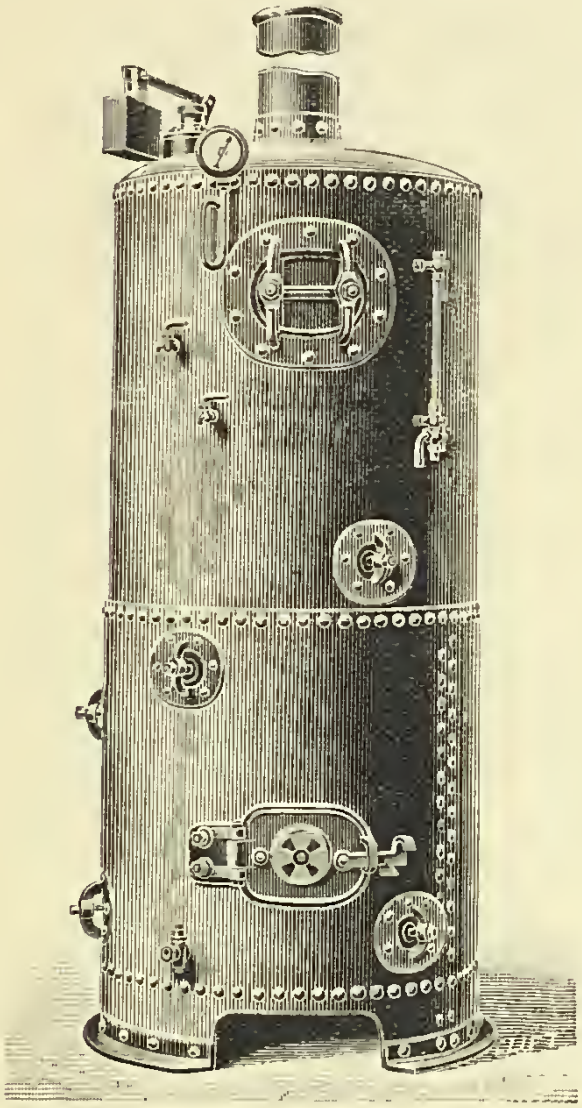
HOW TO ORGANISE, BUILD, AND WORK A CREAMERY.

IN these days of keen competition and trade combinations, it is essential that the dairyman should be able to produce the very best quality of butter and cheese, and that in such quantities of a uniform nature as will ensure his getting a steady and reliable market. This can only be done in most districts by combination, and such combination generally results in the establishment of a creamery, or cheese factory; but more especially is combination necessary in the case of the butter-maker, as butter is an article of food for which there is an almost unlimited demand, and it is well-known that two or three different makes of butter cannot be blended without injuring their quality and texture.

The creameries in these Islands may be divided into two classes, viz.—co-operative and proprietary. The co-operative ones are those owned and run by the farmers, or milk producers for the purpose of manufacturing their own butter. The proprietary creameries are those owned by private individuals, or public companies, and run by their owners for the purpose of making a profit to themselves.

The organisation of a co-operative dairy is in many cases

somewhat difficult. The farmers have to be got together, meetings have to be arranged for and addressed by persons capable of showing what benefit they are to derive from the establishment of this dairy, as well as giving all details concerning the amount of capital required, methods of working, sites suitable, &c. &c.



Illus. 24.

VERTICAL BOILER FOR SEPARATING STATION.

In the event of the farmers deciding to start a creamery, and they having discovered that they are likely to get the milk of a sufficient number of cows to warrant their being able to work the business profitably, the next thing to be done is to register themselves into a co-operative society under the Friendly Societies Act. This is done in preference to registering as an ordinary joint-stock company, as it is much less expensive.

A main dairy, to be successfully worked, should have at least the milk of 600 cows, and an auxiliary or separating-station would require the produce of at least 250 cows.

When a co-operative dairy is registered, shares are subscribed by the farmers, generally to the extent of £1 per cow, and the payment of the different calls on the shares may be arranged to suit the circumstances of the society. The capital required to start a fully-equipped main dairy of the most modern type, capable of dealing with 880 gallons of milk per hour, and the cream from say four auxiliaries, would be about £1500. A first-class auxiliary to separate 440 gallons per hour could be successfully started with a capital of say £400. These figures in each case do not include a freezing-machine, or cooling-plant, which I think is essential for every main dairy. If this was adopted the amount of capital required would be say £350 more.

The societies after being registered generally appoint a committee of management, whose members require to be re-elected yearly. This committee should consist of 7 to 10 for main dairy, and delegates from auxiliaries; but the tendency is to have too many on the committees. The old maxim, "Too many cooks spoil the broth," can, unfortunately, be too often applied to the management of dairies.

The first duty devolving upon a newly registered society is the selection of a suitable site on which to build their dairy. This is a most important point, and is often sadly neglected by prospective creamery owners.

The first point, and the most important to be considered, is the water supply. A good water supply is invaluable, and an inferior, or scanty water supply is enough to ruin any dairy. Before taking a site it should be ascertained that a supply of at least 4 gallons of water per gallon of milk to be dealt with, is available, and in the case of a main dairy, at least, this should be good cold spring water. Where a full supply of spring water is not available, the cooling of the milk, washing up, and boiler feeding should be done from water drawn from a stream,

or lake, and the spring water used for butter-making and cooling the cream.

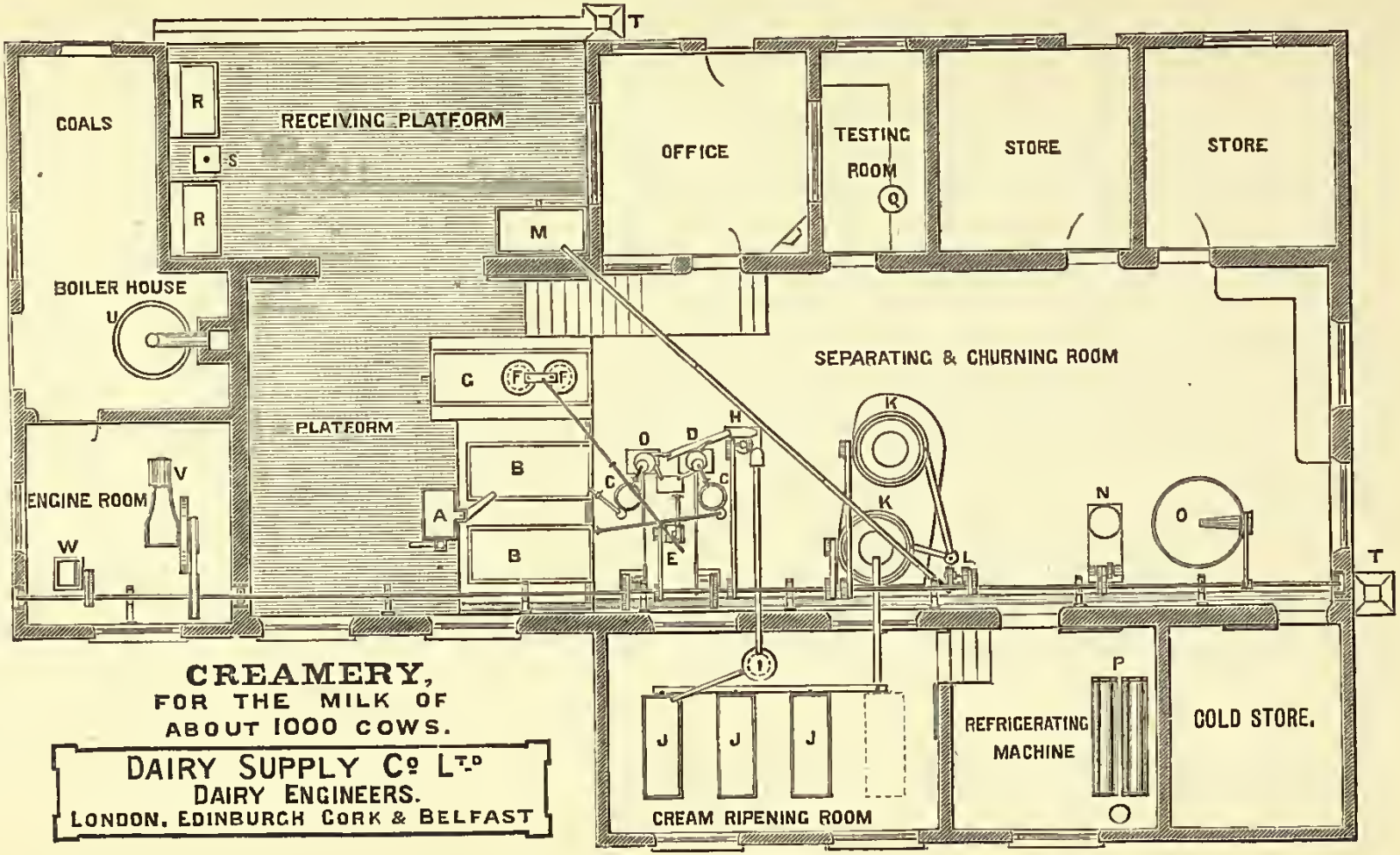
The next point to be considered, in the selection of a creamery site, is the disposal of the sewage, and the creamery should be built upon ground with a good fall-away from it, and with a stream in the vicinity to which the sewage could be conducted. In securing the site, care should be taken to see that the necessary rights are obtained for the laying of the drains for disposal of sewage through neighbouring lands, &c.

Having satisfied ourselves that a sufficient supply of water is procurable, and that our site is situated satisfactorily as regards disposal of sewage, we next come to consider what might be termed the general aspects of the site, *i.e.*, its situation in relation to the surrounding country from which the milk is to be drawn. The creamery should be situated, if possible, in close proximity to cross roads, which pass through the different districts in which the milk is produced, and should be built on ground with a fall if possible towards the south. Of course the main dairy should be built, if possible, near a railway station.

Having secured a suitable site, we come to the building of the dairy.

A dairy building should be built of stone or brick, and should, if possible, be built with the gables facing east and west. A main dairy or churning-station would require about half-an-acre of ground, and an auxiliary about a quarter-acre.

There are a great many desirable plans of dairies, and it would be impossible to lay down any standard as to what ought to be adopted in this respect, as no two creameries are working under precisely the same circumstances, or doing the same class of trade; but a creamery established for making butter only should have the following compartments, viz.—milk receiving-room, cream ripening-room, churning and working-room, cold-store, testing-room or laboratory, separated



Illus. 25. PLAN OF CREAMERY OR MAIN DAIRY FOR THE MILK OF 1000 COWS.

and butter-milk delivery platform, office, engine and boiler-room, and coal store. (I append a plan of what I consider a good butter-making dairy, suitable for dealing with 2000 to 4000 gallons of milk per diem, and the cream of say four auxiliaries handling 1000 gallons per day each.)

Regarding auxiliary dairy buildings, these may be of wood or galvanised iron, instead of brick or stone, and should consist of boiler-room, separating and scalding-room with new milk platform, office, separated milk-delivery room, and coal store, and I consider the appended plan of auxiliary, suitable for dealing with 1000 gallons per day, a good one.

In the building of a dairy great attention should be paid to the lighting and ventilating. The cream-room should be to the north, and any of the dairy windows which face to the south should be fitted with blinds.

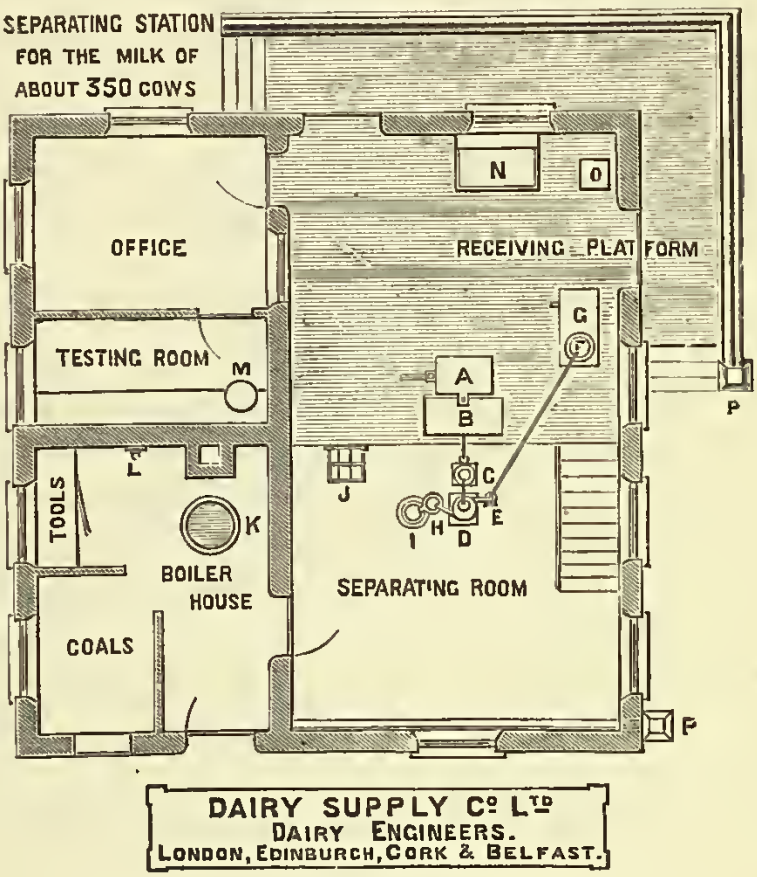
It is essential, to ensure perfect cleanliness and sweetness, that every part of the creamery should be perfectly lighted, and abundance of windows should therefore be provided. The windows should open at the top to assist ventilation, and Louvre ventilators, 12 feet apart, should be fitted in roof.

The floors of the dairy and all platforms should be of concrete, consisting of three parts washed sand and one part London Portland cement, on top of a bed of broken stones thoroughly pressed down. The dairy walls, &c., should be of dimensions shown in plan, which is drawn to scale.

Having organised our creamery, selected our site, and erected the building, we next come to the working or management of the dairy, and this is a subject on which we think that a whole book could be written, but in this case as our space is limited, we will be compelled to be brief and merely touch on the most important points.

In a butter-making creamery, handling say 2000 to 4000 gallons of milk daily, the staff should consist of manager, assistant

manager, engine driver, general assistant and two dairymaids. It is a very bad policy to attempt to work a dairy short-handed, and a great deal of money is undoubtedly lost yearly in our creameries by this "penny wise and pound foolish" system. The manager of a creamery ought to have full control of all the hands in the dairy, and have power to dismiss and take on hands as he thinks fit; if he is not to be trusted with this authority, he is not fit to be entrusted with the management of



Illus. 26.

PLAN OF SEPARATING STATION FOR THE MILK OF 350 COWS.

the creamery. He should superintend all the work which goes on in the dairy, and be thoroughly conversant with every phase of dairy-work.

He should also be able to conduct all the correspondence, superintend the book-keeping, and be able to look out for and secure the best markets for his produce.

What I consider the important points connected with the working of a dairy may be classed under the following headings, and I will deal with these briefly, each in turn:—

(1) Receiving or taking in milk.
(2) Taking samples.
(3) Testing milk.
(4) Heating and "pasteurisation."
(5) Separating.
(6) Cream ripening.
(7) Churning.
(8) Working and packing.
(9) Marketing.

(1) Receiving or Taking in Milk.—This is a very important point indeed, and should be superintended personally by the manager every day. No milk should be received unless brought to the dairy in tinned vessels, and before being emptied into the measure, or weighing machine, each can should be carefully examined; if tainted or flavoured in any way, it should be refused. Milk which shows any signs of being mixed with goats' milk, or of having been tampered with in any way whatever, should be refused, the supplier fined, and his name published as a caution to others. Too much care cannot be exercised in this way, as, the milk being all mixed together, one small supplier's little lot of bad or tainted milk may destroy the whole day's output of the creamery. Before the milk is emptied into the receiving vat it should be sampled, which brings us to our second point—

(2) The Taking of Samples.—This, it will be evident to

everyone who knows anything about dairy-work and the paying of milk in a just way, viz., according to its quality, is an important point, and it must be carried out with the greatest possible care and attention.

Illus. 27. COMPOSITE SAMPLE BOTTLE.

There should be provided for each supplier a sample bottle of flint glass, to hold not less than eight liquid ounces, which bottle should have a wide open mouth, say about 1½-inch diameter with glass stopper.

These bottles should have frosted labels, so that the name or number, or both, of each supplier could be written on its side with an ordinary lead pencil. These bottles are used for what is known as the composite system of sampling, which system is now universally admitted to be the fairest and most reliable. There should be a rack or cupboard provided for these bottles on the milk platform, which rack ought to be under lock and key; as each bottle is placed on the rack—at the beginning of the week or fortnight, as the case may be—a preserving pellet of bicromate of potash ought to be dropped into it. This serves to keep the sample fresh for testing until the test is made, usually every 7 or 14 days.

Illus. 28. PLUNGER OR STIRRER.

The whole of each supplier's milk should be emptied into one receptacle, and this should be vigorously stirred two or three times with a plunger or stirrer (*see illustration*) specially made for the purpose.

The sample should then be immediately taken by means of a dipper, or small vessel with a spout and a long handle holding ½ or 1 liquid ounce (if test is made weekly, 1 oz., if fortnightly, ½ oz.)

which sample should then be transferred to the sample bottle bearing the name or number of the supplier.

A sample should be taken of every consignment of milk brought to the creamery, that is, every time a patron brings milk to the dairy a sample should be taken and placed in his bottle. The next point we have to deal with is the testing of these samples.

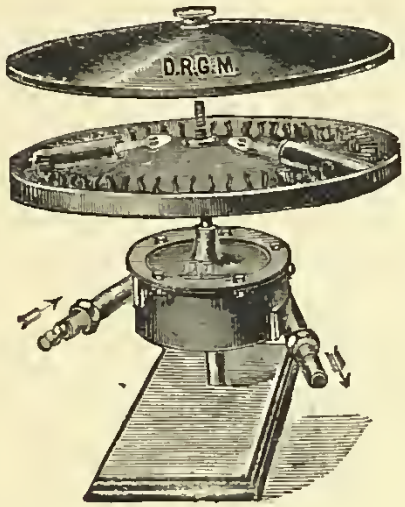
(3) TESTING MILK.—The testing machine, or system mostly in use in Great Britain, is the "Gerber," so named after Dr N. Gerber, of Zurich, the inventor of the machine. The process of testing whole milk by this machine may be briefly described as follows:—

Two different chemicals are used viz., sulphuric acid and amyl alcohol. The sulphuric acid should be best water-white, and should have a specific gravity of ·815 to ·816 at 60 deg. Fahr. The amyl alcohol should have a specific gravity of ·815 to ·816 at 60 deg. Fahr., and boil at 262 deg. to 266 deg. Fahr.; care should be taken to see that pure alcohol is used, entirely free from fatty matter.

The test bottle or butyrometer is placed, mouth up, in the wooden stand supplied with the machine, and 10$^{c.c.}$ of sulphuric acid measured into it; to this is added 1$^{c.c.}$ of amyl alcohol, and the alcohol should be allowed to flow slowly down the side of the bottle on the top of the acid; to this is then added the milk, 11$^{c.c.}$, which should be drawn with the pipette from the thoroughly mixed sample, and allowed to run slowly down the side of the bottle on the top of the acid and amyl alcohol.

The butyrometer should then be carefully and tightly corked with the rubber stopper, and after corking, the whole mass should be shaken until all the curd or casein has been dissolved by the sulphuric acid, and the fat liberated. The butyrometer is then placed in the disc and rotated for from three to five minutes, not

less, after which it can be taken out and the percentage of fat clearly read off in the graduated neck of the bottle.



Illus. 29.
TURBINE GERBER TESTER.

In testing separated or buttermilk, the same *régime* is followed with the exception that the butyrometers should be rotated at least twice, and placed in a bath containing water at a temperature of not less than 160 deg. Fahr. between the rotations. Having described the process of testing, we next come to—

(4) HEATING AND "PASTEURISING" OF THE MILK.—The milk should not be separated at a lower temperature than 100 deg. Fahr., and it has been found that better results have been obtained by separating at a much higher temperature than this; I would recommend separating at temperatures of from 140 deg. to 165 deg. Fahr., especially if the cream is not "pasteurised" after leaving the separator. In winter time, when cows are being hand-fed, it will be found absolutely necessary to separate at a temperature of from 150 deg. to 165 deg. Fahr., in order to destroy the taint of the feeding in the cream, if it is not "pasteurised" after separation. The separated milk ought to be "pasteurised," *i.e.*, heated up to 185 deg. Fahr. after leaving the separator, and cooled down as low as possible before being given out to the suppliers. The cream ought to be cooled down, immediately after being separated, to 65 deg. Fahr. for butter-making. Of course, where a freezing-plant is used, it is advisable to "pasteurise" the cream to 185 deg. Fahr. after its separation, and cool down to 40 deg. Fahr. for cream selling.

(5) SEPARATING.—The advent of the cream separator may safely be said to have entirely revolutionised the dairy trade, and this machine has now certainly been brought to a very high state of perfection.

The separation of the milk is a point in the working of a dairy at which considerable loss very often occurs, and too much care cannot be given to looking after the separators. The separated milk from each machine should be tested every run, and great care should be taken to see that the proper speed of the machine is maintained. If the speed is too low the separation will be imperfect, and if the speed is too high the wear and tear on the machine will be abnormally great; if the machine is running at much over its proper speed it would be even dangerous. A separator in good working order should not leave more than ·15 of 1 per cent. of fat in the separated milk, and with careful handling the Alpha Laval machines can be got to run at an average of ·10 of 1 per cent. of fat in separated milk.

Before leaving this point I would like to say a word about the cream trade as applied to creameries, as I am of opinion that many of our butter-making factories might do a very profitable business in this line, if properly looked after. Cream for sale in jars should be run at a proportion of about 8 per cent. of the whole, with milk having an average butter test of say 3·65; it should be thoroughly cooled immediately after separation, and before being potted in jars it should be mixed with a special cream preservative to the extent of from ½ to 1 oz. to the gallon, according to the season of the year.

The jars should be tightly corked, with tinfoil underneath the cork to render the jar air-tight, and then neatly tied over with parchment paper, and labelled. Cream for butter-making should be run at not less than 12 per cent. of the whole. Our next point is the ripening of cream for churning.

(6) Cream Ripening.—If cream has been "pasteurised" and cooled, it ought to be ripened with a pure culture, or starter, *i.e.*, a preparation of the proper bacteria, or germ, which by its action on the cream sours it, or turns the sugar of milk into lactic acid. This pure culture, of which different makers are in the market, should not be applied direct to the cream, but is prepared in the following way:

Take a quantity of fresh separated milk, boil it for say 20 minutes in a clean vessel, then cool down as quickly as possible to 85 deg. Fahr., and when at this temperature add the contents of one bottle of the culture.

This, it will be found, will quickly coagulate the milk, and when it has been properly coagulated, about 1½ gallons of it should be added to each 200 gallons of cream—this should be well stirred into the cream.

In cases where the cream has not been "pasteurised" it is useless to employ a pure culture, but the cream should be ripened in vats, and allowed to sour of its own account. In summer, cream should be ripened at a temperature of about 60 deg. Fahr., but in winter it is advisable to keep it at not less than 65 deg. Fahr.

Cream is ripe, or ready for churning, just when all the sugar has been converted into lactic acid, and it should then have a clear sharp acid flavour, not bitter, but what might be called a "sweet sour" taste. I am of opinion that there is no reliable method of testing the acidity, or ripeness of cream, which could be accurately used by a creamery manager, and the only way to know when the cream is ripe is by taste and smell, both of which must be gained by experience.

If cream is allowed to ripen too long, what is known as the butyric ferments set in, which cause a taint in the butter, and if it is churned before being properly ripe, the butter is greasy and flavourless, and there is a loss of fat in the butter-milk.

When the cream is ripe, and only when it is ripe, ought it to be churned, which brings us to our 7th point:

(7) CHURNING.—To churn cream is merely to give it as much concussion as will cause the minute particles, or globules of butter-fat to come together, and finally form particles of butter called grains. We have already dealt with the churning of cream in chapter VII., and most of the remarks anent the churning of small quantities of cream may be applied to large churnings. I am of opinion, however, that cream should be churned in a creamery at a temperature of 51 deg. to 52 deg. Fahr. in summer, and 53 deg. to 54 deg. Fahr. in winter. It has been found that it will pay creamery proprietors to buy ice in summer time to enable them to reduce the temperature of the cream to the figures above stated, as where higher temperatures are used the loss of fat in the butter-milk is considerable. The butter-milk from every churning should be carefully sampled and tested with the "Gerber" tester, due allowance being made for the water added during the churning.

The butter having been churned and washed, the grain should be conveyed to the butter-worker, which, together with the churn, we will describe in our next chapter.

(8) WORKING AND PACKING.—The working of the butter is a point at which creamery managers and dairymaids very often make serious blunders. The butter should be worked only until the water, or rather the excess water, has been squeezed out of it.

The butter in the grain should be passed twice under the roller, then the salt should be added to the extent required; after having been carefully weighed it should be sprinkled on the butter by means of a small salt strainer. The butter should then be passed two or three times more under the

roller, after which it should be transferred to the slate or marble slabs, and left there for at least three hours to allow the salt to thoroughly dissolve in the mass. At the end of this time it ought to be again put on the worker, and worked until the excess water is thoroughly expelled. This is ascertained by cutting and squeezing a small piece with the Scotch-hand, as explained in chapter VII. The salt that is used for curing butter ought to be of the very best quality, as bad salt will effectively ruin the best butter. (Please see last paragraph of chapter VII.)

After being worked the second time the butter should be transferred to the packages used—pyramid boxes, or "keils," as the case may be.

The pyramid boxes are made in sizes of from 7 to 56 lbs., and should be of best Quebec spruce without knots, or any resinous matter whatever.

The "keils" should be of seasoned beech. Before the butter is placed in the packages they should be lined with first-class vegetable butter parchment, which has been previously moistened in cold water. The package should be placed on the weighing-machine, and the tare taken.

Then the butter should be firmly packed into the receptacle with a butter-packer, and the package firmly nailed up or hooped as the case may be; before being despatched they should be encased in covers of rough jute canvas. It is necessary, in weighing butter, to allow at least 1 lb. per cwt. for shrinkage.

A very profitable trade may be done by most creameries in selling butter made up in 1 lb. and ½ lb. rolls. There are numerous machines in the market for the moulding or shaping of these rolls, but I am of opinion that with a little practice they can be made as quickly and more neatly by the hand as by any machine, all that is required being a pair of strong boxwood Scotch-hands or beaters.

The rolls may be encased in light cardboard boxes, and packed in cases, or they may be simply rolled in parchment paper and packed in boxes on end.

Having got our butter properly made and packed, we next come to the disposing or selling of it, which brings us to our last point in this chapter, viz., the marketing of the butter and other produce of the dairy.

(9) MARKETING.—Now, this is a matter which I think is often sadly neglected, especially in our Irish creameries. There is no reason whatever why the creamery proprietor should not sell direct to the retailer; and yet how many of our dairies content themselves with merely shipping their produce week by week to some large wholesale firm, who probably sell to another wholesale house, and from thence it goes to the retailer, before it reaches the consumer. I think the profits should be confined to at least one wholesale house, and creamery managers ought to visit our large cities, and create a connection with the retailing firms in these cities; thus securing larger profits for themselves, and a better name for our home-made article. The fewer people who come between the manufacturer and the consumer the better; the consumer is bound to get the butter in better condition, and the dairy man a higher price.

CHAPTER X.

HOW TO USE CREAMERY MACHINERY.

IN dairying, as in all other industries, the use of machinery has now become a very important factor. The advent of the cream separator may be said to have really been the beginning of the factory system as regards the manufacturing of dairy produce, and since then, dairy machines of every description have gone on steadily improving; in fact, so rapid has the advance in this direction been of later years, that it is almost impossible for any dairy factory to keep fully abreast of the times in the matter of machinery, because of the expense which would be incurred in continually changing the plant. Of course, in town dairies and dairy farms, the machinery is very often worked by hand, and we will not say much in this chapter regarding hand machines, as our aim is to give as accurate an idea as possible of the construction, maintenance and management of machinery in dairy factories.

The part of the machinery of first import in a dairy factory is the motive power, generally a steam engine and boiler; but as these are not what might be called actual dairy machines we will not say much concerning them here. The boiler should be high pressure, working at not less than 120 lbs. (as steam at this pressure is dryer and more suitable for dairy work than at lower pressure), and should be, undoubtedly, of

the Cornish or Lancashire type. We have found through practical experience of almost every type of boiler made, that the Cornish or Lancashire boilers are far and away the most satisfactory and economical in the end.

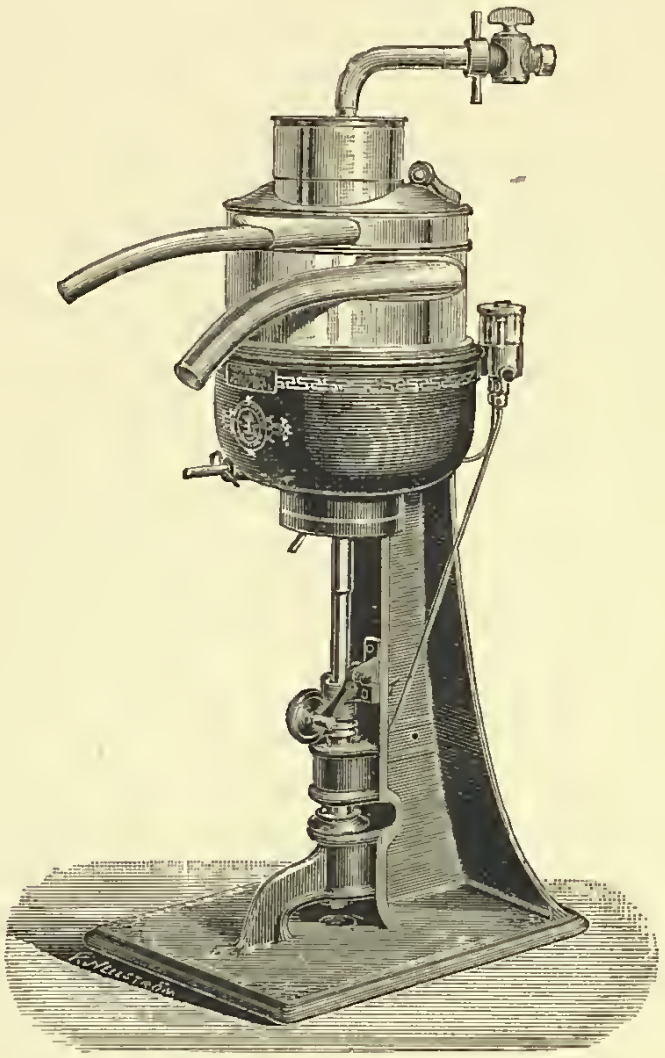
A great deal has been said, of late years, about the proper size of boiler for creameries; but, I am of opinion that it is a point on which creamery owners should err on the safe side, and for main dairies handling say from 3000 to 10,000 gallons of milk per day, including auxiliaries, the boiler should be capable of evaporating about 2000 lbs. of water per hour.

For auxiliary dairies, I have found the ordinary vertical cross tube boilers, when well covered with asbestos composition, as economical as any, taking management, upkeep, and all other factors into consideration.

For an auxiliary handling 500 to 2000 gallons of milk per day, I would recommend a boiler 11 feet × 4 feet, 6 inches, with four cross tubes, working at not less than 100 lbs. pressure Before leaving this matter of boilers, I would like to say a word about steam pipes in dairies. These are as a rule not covered with non-conducting composition, and a great deal of loss is caused thereby, besides their raising the temperature in the dairy very considerably. This composition is not by any means expensive and all main steam pipes at least should be covered with it.

As it is essential to have steam in a creamery, most dairy factories are worked by steam engines, although in some cases oil and gas engines are used, and here let me say that I do not believe in an oil engine for a dairy. The smell from the oil is almost certain to penetrate into the creamery, and cream and butter, it is well known, are both very readily affected by any such taints as petroleum, or other such volatile substances. To drive all the machinery including ice plant in a fully

equipped main dairy, an engine is required capable of developing 25 (actual or brake) horse-power. This should be of the horizontal quick-speed type, and be fitted with "Pickering" governor. Dairy machinery, especially separators, are very



Illus. 30. ALPHA LEVIATHAN SEPARATOR.

often ruined through bad governors on the engines, and we can confidently recommend the "Pickering" from long experience of various makes of governors.

The premier machine next to the motive power is the

separator, of which there are various makes in the market; but the machine which is now universally used in British creameries is the "Alpha-Laval." This separator, which is of Swedish make, is the invention of the well-known Swedish inventor, Dr Gustaf De Laval. The largest size of this machine, the "Alpha Leviathan," has a skimming capacity of 440 gallons per hour. This size of machine is most suitable for dairy factories, and each creamery ought to have at least two separators, as, if anything were to go wrong with one the other could be fallen back on.

The "Alpha-Laval" cream separators are run at a speed of 5600 revolutions of the bowl per minute, and the intermediate motions of the belt machines are intended to be run at 600 revolutions per minute. Great care should be taken to see that the separators are run at the proper speed, and that all the lubricators are in thorough working order, so that all the bearings may be properly oiled.

There are two types of "Alpha-Laval" machines made, viz., the belt-driven, and the steam turbine. The steam turbine machines have a turbine motor attached, and all that is required is a jet of steam from a boiler.

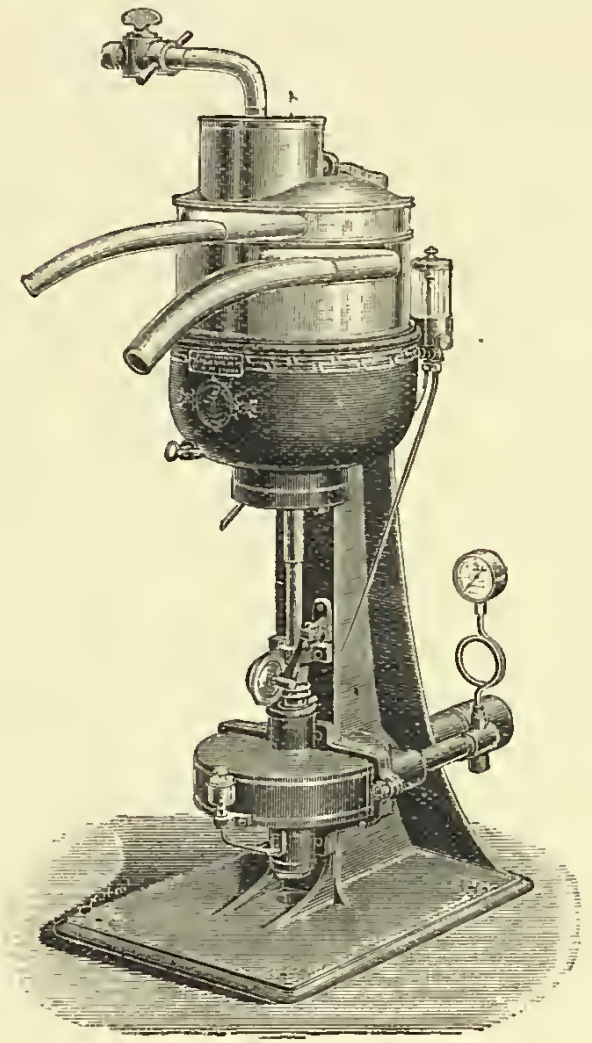
These machines are used nearly always in auxiliary dairies, as by their use the erection of an engine and shafting is dispensed with and a boiler only is required.

The separators should be set upon cast-iron pedestals sunk in a block of cement; the cement block should be 9 in. above floor, and the pedestals should rise 3 in. above the block to allow the space beneath the sole plate to be cleaned out daily. They should be set dead level on the india-rubber washers in tin cases which are provided with the machines. The washers are placed on the top of the cast-iron pedestals, and on them the separator rests.

The distance between the intermediate motion and the

separator, in the case of belt-driven machines, should be 6 ft. 11 in., centre to centre.

The following spare parts should always be kept at hand by separator users in case of breakdown, viz.:—top-bearing, lower



Illus. 31.
ALPHA LEVIATHAN TURBINE SEPARATOR.

spindle, upper and lower bushings, steel points, and tread wheels and axle.

Regarding the care and management of separators of any make, the following are the principal points to be observed.

viz.:—setting or position of machine, *i.e.*, it should always be dead level; lubrication; renewing of parts before they are too far gone; general care in handling the various parts, and keeping the separator clean.

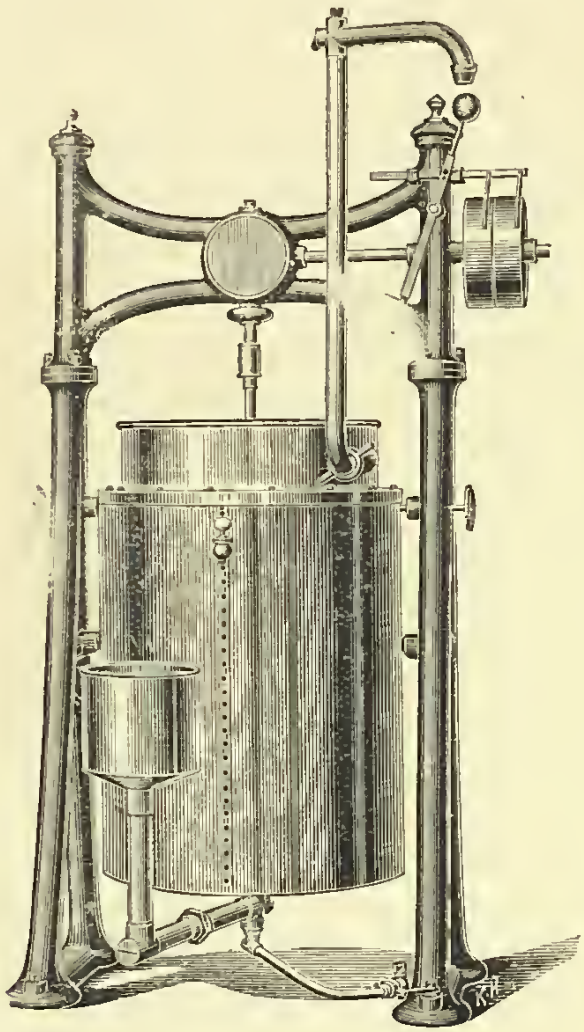
Whenever the bowl of a separator starts to shake or to make a noise in running, the machine ought to be seen to at once, as a separator which is not running smoothly will never skim clean.

Separators which are carefully managed and well looked after will last twice as long, and cost half as much for repairs as machines which are carelessly used or in any way neglected.

In modern creamery practice, the machine which may be said to be most closely allied to the separator is the "pasteuriser," and of these there are many and various types in the market; in fact, their name is legion.

All creameries, or butter-making dairies should have three "pasteurisers." One to be used as a heater for the new milk previous to its being separated, one for "pasteurising" the separated milk, and the third for "pasteurising" the cream. In main dairies, or auxiliaries where an engine or shafting is used, belt-driven "pasteurisers" should be used. These should be of the vertical pattern arranged to tip over to allow of their being thoroughly cleaned; the inside casing or heating surface over which the milk flows ought to be of tinned copper, and the outside casing of galvanised steel lagged with felt, and with another sheet of steel casing outside the felt. The heater should have a paraboloid heating surface, and be fitted with fast and loose pulleys and belt-shifter; it should, of course, be of the self-elevating pattern, to raise the milk at least three or four feet above the level of the inlet, and should be capable of heating 880 gallons of milk (where two separators are used) from 60 deg. to 184 deg. Fahr.

The separated milk "pasteuriser" should be of the same pattern, and be capable of heating the capacity of the separator, or separators, less 10 per cent. from 110 deg. to 190 deg. Fahr. The best cream "pasteuriser" is of the same make as those



Illus. 32. BELT-DRIVEN "PASTEURISER."

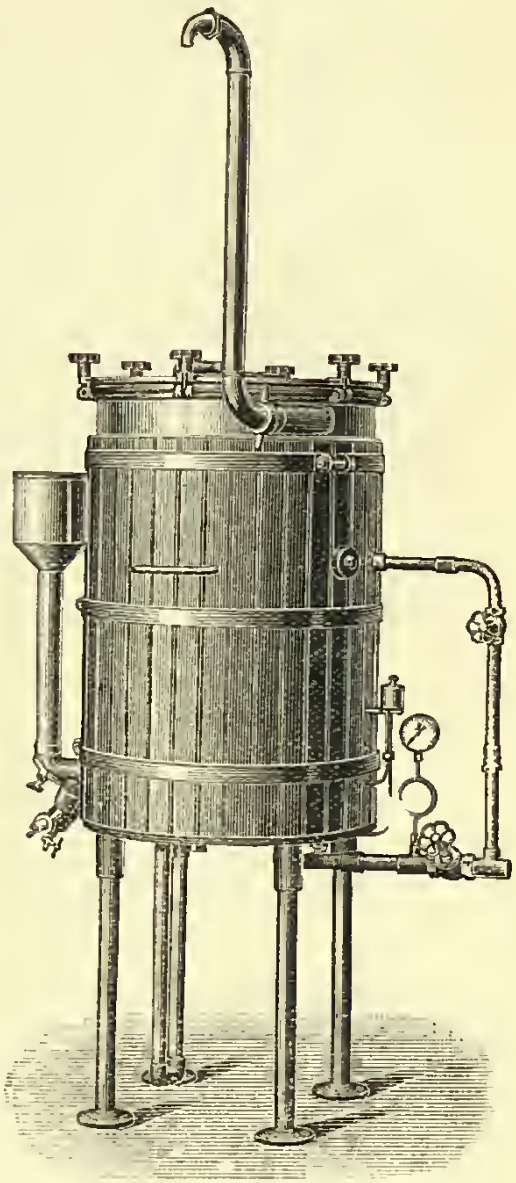
described above, and should be capable of raising the temperature of 15 per cent. of the capacity of the separators from 110 to 184 deg. Fahr.

For separating stations where boilers only are used, and no

shafting, steam turbine "pasteurisers" are required. The best known of these is the "Laval." For the new and separated milk the self-elevating pattern should be used, while for the cream the ordinary gravitation pattern will be found most suitable. The same remarks as to capacity apply to these, as we have stated regarding the belt-driven machines.

All "pasteurisers" should be fitted with self-emptying ejectors, to enable the milk or cream, left in the "pasteuriser" at the finish of the run, to be delivered on to the cooler or separator, without the use of buckets.

The principal point to be observed in looking after "pasteurisers" is to see that they are kept thoroughly clean. As soon as the run is over they should be filled with boiling water, to which should be added a handful of washing soda. This should be allowed to stand in the machines for about an hour, after which they should be thoroughly scrubbed out, and left without a particle of milk adhering to the heating surface.



Illus. 33.

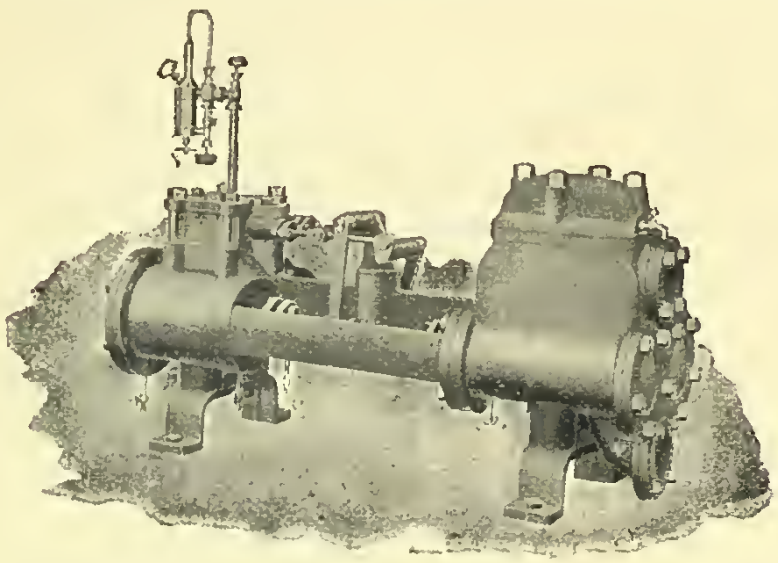
SELF-ELEVATING "PASTEURISER."

In the case of the elevating turbine machines, care should be taken to see that they are not allowed to run too fast (150 to 180 revolutions per minute is the proper speed), and they should also be kept well lubricated with good thick oil. That used for the turbine separators will be found most suitable. From the "pasteurisers," I naturally pass on to the coolers, though these are not what could be properly designated machines, but would be more suitably classed as apparatus. The best cooler for creamery use is undoubtedly the well-known circular pattern. They should be of strong copper, doubly tinned, and it is advisable in selecting a cooler, to have one of a little larger capacity than is actually required. Circular coolers should be fixed or set perfectly level, and no special care is required in their maintenance.

Illus. 34.
VERTICAL LIFT PUMP.

Following the coolers we come to deal with the pumps in the dairy. They are used for both water and milk. The water pump may be of any type to suit the ideas of the creamery owner, but I would recommend duplex steam pumps, as being the least liable to get out of order, besides having the advantage of their not requiring the engine to work them. They can be used at all times of the day, as long as there is steam on the boiler, whether the engine is running or not. For a central creamery, handling say 1000 to 4000 gallons milk daily, a pump capable of raising 2400 gallons per hour is required, and for an auxiliary with one separator, one to lift 1600 gallons per hour should be used.

The milk pump comes more properly under the heading of dairy machinery, and there are a number of varieties of these made, such as the cog-wheel type of rotary pump; the Danish rotary, the semi-rotary, the vacuum, and the lift-and-force pumps. Of all these types, I am of opinion that the vertical lift-and-force pump, as specially made for pumping



Illus. 35. DUPLEX STEAM PUMP.

milk and cream, is the most reliable, and best all round milk pump for creameries. The Danish rotary is a fairly good type of pump, but its liability to get out of order places the lift-and-force far ahead of it. A lift-and-force pump for milk should have a barrel with plunger and rod, and all valves of brass or gun-metal throughout; the piston or plunger should be packed with brass spring rings, and there should be no leather or other textile or rubber packing about it whatever. It should be provided with instant couplings, and be constructed in such a way that it could be easily taken apart for cleaning. The plunger rod should be provided with a guide to prevent it wearing the packing gland at top of barrel.

This pump can be safely used for raising either new milk, separated milk, or cream. It should not be run at a speed exceeding 50 strokes per minute.

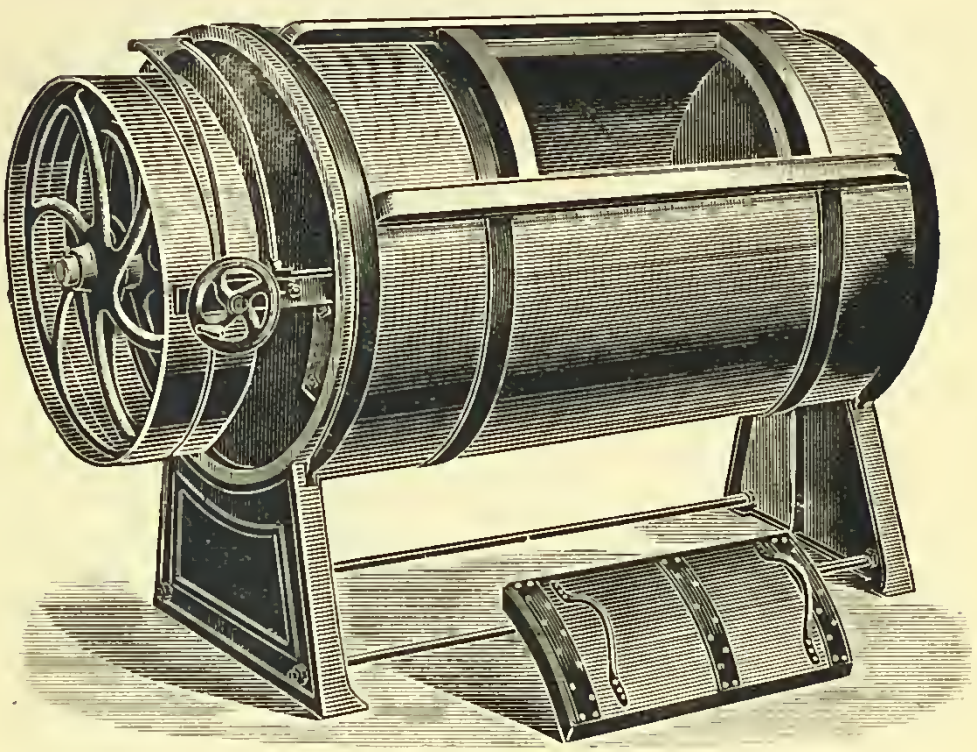
For main dairies, or auxiliaries with shafting, the belt-driven pattern is used, and for auxiliaries with boiler only, the steam direct-acting is the best. These direct-acting steam pumps, specially made for milk, have only been lately introduced, and they will, I am sure, be largely used in separating stations in place of the rotary and semi-rotary patterns used heretofore.

The next machine we will deal with is the churn; there are as many different types of creamery churns in the market, as there are days in the year. For small creameries, dealing with say 200 to 300 gallons milk daily, the over-end type of churn is, I consider, a very good one; but for the ordinary butter factory, the "stationary barrel," with revolving dashers, or the well-known "Streamlet" patterns, are the most satisfactory.

If the cylindrical churn is used, it should be made of well-seasoned kauri wood, have a large wide mouth, or opening, and a glass eye-piece in the end, remote from pulleys, to allow the operator to watch the process of churning, without removing the lid.

The churn should be mounted on a cast-iron base plate, and should have, for most of the creamery sizes, 36 in. pulleys. The proper speed to work this class of churn at, is 45 to 50 revolutions per minute: A great deal of time may be saved by using, along with these churns, a butter-box or trough, which should be of sufficient size, and easily contain the full churning capacity of the churn. In cases where the butter-box is used, the churn should be fitted with a large outlet sluice-valve, to allow of the whole contents of the churn being precipitated into the box in a few seconds. The box is placed

alongside of the churn, and commanded by the outlet, and while one churning is being washed and dealt with in the butter-box, another can be churning in the churn. This trough should have a strainer across one corner, behind which the connection to butter-milk pump is made.



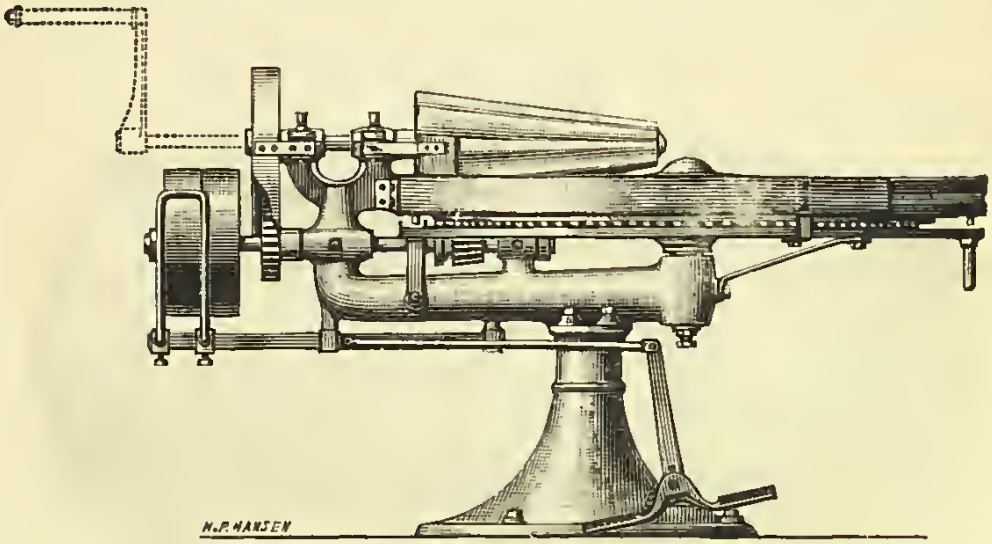
Illus. 36. FACTORY CHURN.

If the "Streamlet" churn is used, it should be made of pitch-pine, well-seasoned, and the dashers should be of oak.

In selecting a churn of any type, care should be taken to see that it is of good and strong make throughout, as a first-class churn, reliably made, will last for a very long time without any repairs, whereas a lightly-constructed machine requires constant attention and repair.

Having fully described the churn, I will now pass on to the butter-worker; and, of course, so far as creamery work is concerned, the rotary or circular butter-worker is the universal

machine, and the best. There are largely used in America so-called combined churns and butter-workers, but I don't believe at all in these, as they all tend to produce greasy butter.



Illus. 37. "KELT" BUTTER WORKER FOR BELT POWER.

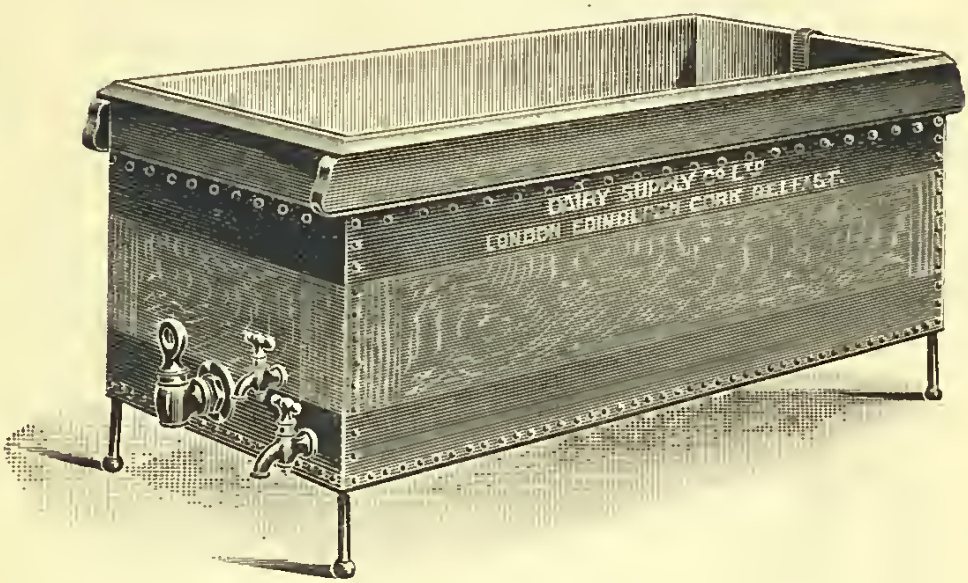
A creamery butter-worker should have a cast-iron frame of the self-contained or pedestal pattern, in preference to the girder type, unless in very large dairies where enormous quantities have to be dealt with; in these cases the girder principle is resorted to, in order to procure sufficient strength for very large machines.

The table should be of well-seasoned beech, with a slope, from the centre to the circumference, of about 1 in. in every 15 in., and should be asphalted below, to prevent the moisture rotting the wood underneath. All the bright parts should be heavily tinned, and the belt-shifter should be so arranged that it could be moved by the foot of the operator, without changing his or her position from the edge of the worker. The gearing which works the actual table, should be well out towards the edge of the circle (not on the edge), and the cogs should be attached to the bottom of the table, and not on a wheel fixed to centre spindle. The roller should also

be of beech, and the corrugations should be straight and fairly deep; about two inches of a groove on a 60 in. table, I consider suitable. In creameries, it is not advisable to have double rollers on a butter-worker, unless there are two persons attending to it.

The drain pipes on a butter-worker should be of ample size, and the lubricators should be of the "Stauffer" pattern, to take solid oil.

For the usual sized creamery with two separators, a table 70 in. diameter will be found most suitable.



Illus. 38. CREAM-RIPENING VAT.

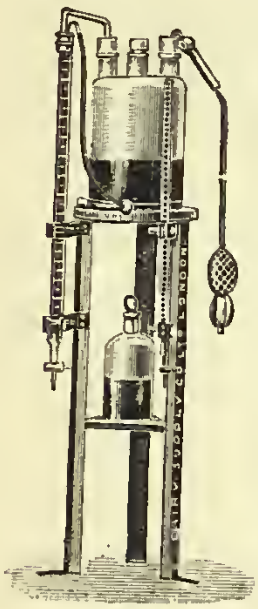
As I have stated in a previous chapter, cream should be ripened in vats, and it might not be out of place to say here a word as to the construction of these. They should be jacketed bottom and sides, and have connections for both cold water and steam. The inside casing should be of strong tinned copper or steel, and there should be no rough joints or soldering in the vats. They should be well sloped from the sides to the centre, and again from the end opposite the outlet top to the outlet. These vats should be at a high

enough elevation to command the churn, so that the cream could flow by gravitation into the churn.

REGARDING MILK TESTERS.

Although our cousins on the other side of the Atlantic still stick to the "Babcock" method, and our neighbours, the Danes, mostly employ the "Lactocryte," we in this country have now almost universally adopted the "Gerber" method, and it is undoubtedly the simplest and most reliable for creameries. I recommend the steam turbine tester, and an automatic measure designed by Dr Veith, for the alcohol and acid.

This automatic measure I consider the best and simplest, and with this and the steam turbine machine, testing can now be easily and quickly done. I have already described the method of testing with the "Gerber" apparatus, and the construction of the machine is so simple, that it is needless for me to say anything more concerning it here.



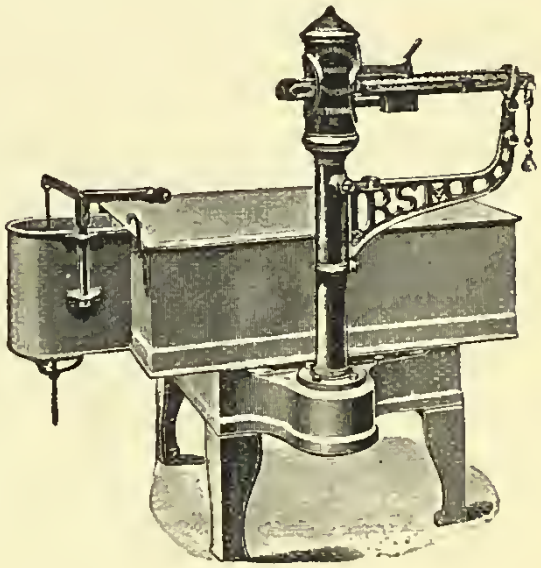
Illus. 39.
AUTOMATIC ACID MEASURE.

The weighing machines used in creameries are an important item, and these may be classed under two headings, viz. :—machines for weighing milk, and machines for weighing butter.

All milk should be received at the creamery by weight, and the new milk weighing machine should be of the steel-yard pattern, with no loose weights to get lost or damaged. It should be galvanised all over, and should register in gallons, quarts, and pounds. The receiving tank should be broad and low, and in creameries of average size should hold 50 gallons.

It should be fitted with an outlet valve (with lever handle) not less than 5 in. in diameter to allow

of its emptying quickly, which valve should overhang the new milk tank. The machine for weighing out separated milk may be of the spring-balance type, and should weigh about 25 gallons at a time; it should be hung from a swing crane with a travelling pulley, to allow of its being easily emptied into any can on the cart which passes underneath it. If desired, an automatic machine as used in most Danish dairies could be used.



Illus. 40.
NEW MILK WEIGHING MACHINE.

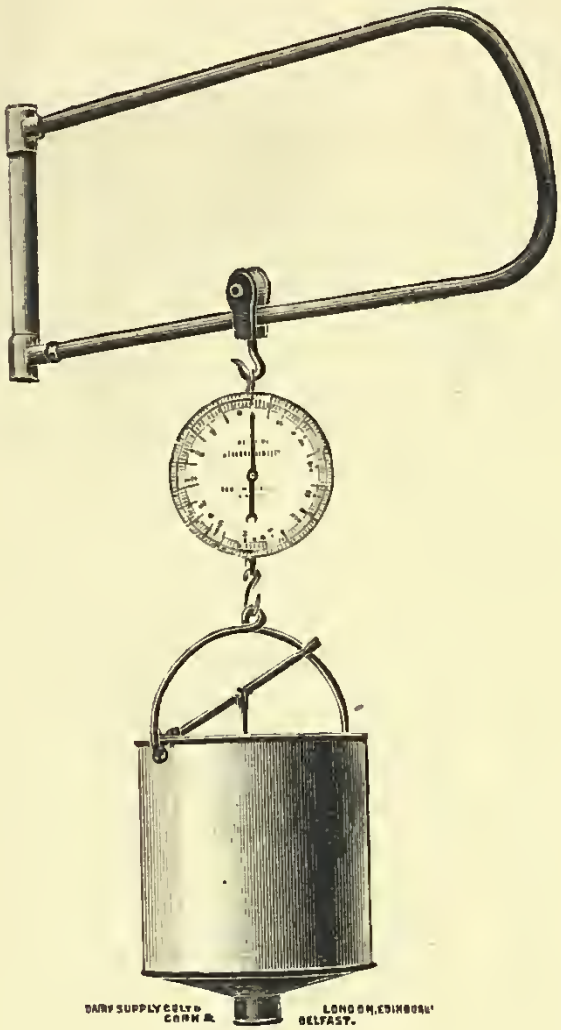
The weighing-out drum on the machine should have an outlet valve in the bottom, about 3 in. diameter.

For weighing butter for despatch, either in large or small quantities, there is nothing to beat the ordinary beam scales; these should be heavily galvanised, and the larger sizes should be of the trolley pattern to allow of their being easily moved from place to place.

Before leaving the subject, I might say a word about the general management of dairy plant.

Dairy machinery as a rule wears out quickly, and too great care and attention cannot be expended upon it.

All dairy shafting and machines running at slow speed should be lubricated with solid oil from which there is no drip, and all the working parts of all the plant should be cleaned and looked after daily; creamery owners will find that care and attention to their machinery in its daily working will repay them over and over again, in the keeping down of the repairs and renewals



Illus. 41.

SEPARATED MILK WEIGHING MACHINE.

CHAPTER XI.

HOW TO UTILISE SEPARATED MILK.

[*Part of this Chapter was written by the author for, and appeared in, "The Journal of the British Dairy Farmers' Association," 24th July 1899.*]

SKIMMED MILK is a farm product, which with the use of cream separators and the introduction of the creamery system, is now manufactured largely in excess of the human requirements of the immediate vicinity of the creamery. The complete separation of the butter fat has raised a prejudice against its use in some parts of the world, so much so that its sale for human consumption has been prohibited in some of the States in America. We cannot understand, however, why separated milk can be reasonably prohibited from sale as a food, seeing it is a well-balanced, healthful, digestible, agreeable, cheap and economical human food. The cheapest food is certainly that which furnishes the most nutriment at the least cost. Five lbs. of separated milk, costing 2d., will furnish the same amount of flesh formers as 1 lb. of round steak costing 1s. There can be no doubt the most profitable way of disposing of separated milk is to sell it as human food; but to do this, the milk must be "pasteurised" and cooled at an early stage, despatched to the cities by express trains and sold perfectly sweet. The charge made by the railway companies for the carriage of this kind of milk to the cities, being equal to the cost of the transit of whole

milk, makes it impossible for many creameries to market it at all, and in cases of this kind the next best method is to utilise it in the rearing of calves, the feeding of pigs, or the making of cheese. There is a practice, introduced into many creameries, where the farmer gets back to his farm 80 per cent. of all he brings every morning in sweet "pasteurised" and cooled separated milk, where it can be used for general farm purposes; in this way he is able to keep far more stock on his farm and keep up the fertility of the soil better than by selling all the milk. Large numbers of calves are now reared on separated milk and feeding meals, and are as healthy and grow into as large feeding bullocks as can be done by any other system, except suckling. Pigs can be profitably fed on skimmed milk at 1½d. per gallon, and it can be fed to horses, cows, sheep, lambs and poultry. The precipitated casein in skimmed milk can be made into certain forms of cement, glue and artificial ivory, but its use in this direction has been very limited; the most promising outlet for large quantities of separated milk, other than calf rearing, is in the baking of bread. Ten years ago, when the creamery system in Great Britain was just in its infancy, we had the privilege of initiating the use of separated milk in bread-making, bringing it before the British Dairy Farmers' Association, and exhibiting samples. Shortly after this the Association introduced milk bread, as a section in their prize list, at their Annual Dairy Show in London, which has been continued with growing interest ever since, and the effect has been to increase the consumption of separated milk in the baking of fancy bread. The loaf bread trade is slower to move in this direction, the milk being more difficult to use with barm or yeast than water, yet we feel confident that the additional weight obtained, richer quality, and finer appearance of the bread will more than pay for the value of the milk and the additional care required, as the following analyses will show.

Illus. 42. "DIAZ"—CHAMPION OF ABERDEEN-ANGUS BREED, R.A.S.E. SHOW, YORK, 1900.
(As belonging to W. Shaw Adamson, Esq. of Carveston Castle.)

ANALYSIS BY STEVENSON MACADAM, ESQ. :—

In One Hundred Parts.	Ordinary Water Bread.	Separated Milk Bread.
Moisture	39·36	38·64
Oil and Fat	0·12	0·51
Albuminous or Flesh-forming Compounds	7·31	9·19
Starch, Gum and Sugar	52·59	51·07
Woody Fibre	0·33	0·31
Ash or Saline Matter	0·29	0·28
	100·00	100·00
Nitrogen	1·17	1·47
Phosphates in ash	0·15	0·15

"These results prove that the creamed milk bread is richer in fatty matter than the ordinary water bread, and that the milk bread is markedly superior to the water bread in albuminous flesh-forming constituents, due undoubtedly to the casein of the milk becoming incorporated with the fibrine of the flour; I am, therefore, clearly of opinion that the milk bread is more nutritious than the ordinary water bread, and is correspondingly more sustaining, alike for daily work, and for the daily wear and tear of the animal frame.

"I have further to state that the milk bread is very sweet and palatable, the milk having been used in a comparatively fresh state, and I can confidently recommend it for general family use.

STEVENSON MACADAM, PH.D.,
Lecturer on Chemistry, Analytical Laboratory,
Surgeons' Hall, Edinburgh.

ANALYSIS BY J. FALCONER KING, ESQ. :—

Report of the analysis of two samples of bread marked No. 1, "Best fine loaf bread"; No. 2, "Bread made with separated milk."

"I have made a careful analysis of these two samples of bread, and the results show that both of them contain very good proportions of the different useful ingredients.

"No. 2, however, is richer than No. 1 in the valuable albuminoid, fatty and starchy matter—the flesh-forming and meat producers—

and possesses, therefore, a higher dietetic value. No. 2 sample was, furthermore, of a very taking appearance. It is also very palatable and pleasant to eat, and in my opinion only requires to be properly known to become a favourite bread.

	No 1.	No 2.
Albuminoids—Flesh Formers . . .	9·00	9·87
Nitrogen in other forms calculated to Albuminoids	0·69	0·37
Starch, Gum, Sugar, &c.; Fatty Matter, Heat Givers and Fat Producers . .	0·80	3·08
Ash	2·20	2·20
Water	37·20	30·44
Fibre	0·36	1·48

J. FALCONER KING, F.C.S.,
Laboratory of City Analyst, Edinburgh."

COMPOSITION OF FRESH BREAD, AS REPORTED BY THE MAINE AGRICULTURAL EXPERIMENT STATION, 1898.

Laboratory Number.	Kind of Bread.	Water—per cent.	Protein (N×6·25)—Per cent.	Fat—Per cent.	Carbohydrates—Per cent.	Ash—Per cent.	Heats of combustion determined—Calories.	Nitrogen—Per cent.	Carbohydrates—Per cent.
6115	Water bread.....	40·40	8·97	1·13	48·59	·91	2,683	1·43	49·41
6118	Water bread.....	40·07	8·81	1·05	49·12	·95	2,704	1·41	49.89
6190	Water bread.....	37·84	9·02	1·03	51·35	·76	....	1·44	52·16
	Average.....	39·44	8·93	1·07	49·69	·87	....	1·43	50·48
6116	Skimmed milk bread..	39·60	9·84	·75	48·58	1·17	2,668	1·57	49·47
6119	Skimmed milk bread..	38·63	9·80	1·10	48·85	1·02	2,752	1·57	49·70
6191	Skimmed milk bread..	35·62	10·29	·98	52·02	1·08	....	1·64	52·96
	Average.....	37·97	9·98	·94	49·82	1·29	....	1·59	50·72

DIGESTIBILITY OF THE PROTEIN OF WATER BREAD AND SKIMMED MILK BREAD IN PEPSIN SOLUTION.

Lab. No.		% Digested.	
6115	Water Bread	95.62	
6118	Water Bread	93·79	
	Average		94·70
6116	Milk Bread	94·32	
6119	Milk Bread	94·10	
	Average		94·21

Illus. 43. TYPICAL CROSS-BRED COW FOR HEAVY STALL-FEEDING.
(Sold in the Edinburgh Market, 27th June 1900, for £27.)

Skimmed milk bread contains more protein (muscle-forming food) than water bread.

Skimmed milk bread is as completely digestable as water bread. The use of skimmed milk in bread-making utilises a valuable waste product of the dairy.

These comparisons show that bread made with separated milk is superior to the ordinary water bread, and, of course, bread made with pure milk would be very much superior, being richer in fat; but the extra cost of pure milk could not be recovered in the extra price of the bread, whereas the additional outcome in the weight and extra value of the separated milk loaf bread more than pays for the price of the separated milk.

Separated milk loaves can also be sold as fancy bread, and do not require to be weighed to the statutory weight of 4 lbs., and consequently a larger profit can be made.

A very common bread with all classes of society in Scotland is the girdle scone; many dairymen have lately added the baking of these scones to their business and find it more profitable than the milk trade, while at the same time it provides a ready market for their separated and butter-milk. The labour required in baking these scones is very small. A hot plate, 3 ft. long by 2 ft. broad, with gas, will keep a man or woman firing as fast as another can put them out. The best class of flour for baking scones, is a flour of good colour, that will drink its own weight in milk; say 10 lbs. of flour will consume 10 lbs. of sour, skimmed, or butter milk, the evaporation in baking in this way is practically *nil*, and you have 20 lbs. of first-class bread for 1s. 8d., or 1d. per lb. at present prices.

The more milk the flour drinks the better the scones, and the more profit to the baker, as the milk is less than half the price of the flour and yields the same output. A special feature in the quality of these scones, however, is the souring

of the milk. Many people seem to think that any kind of milk will suit, and that where the proper sourness has not been attained, it can be made up by an additional quantity of tartaric acid; this is a mistake. Even although the defect were made up in this way, which it is not, the additional cost of tartaric acid is more than a working profit, and the goods want the fine flavour and glossy appearance of scones made from milk coagulated and containing the full quantity of lactic acid.

Dairymen and creamery managers would find it to their advantage to give more attention to the preparation of separated milk for the baking of scones and small bread; that is, how to sour separated milk so as to make it equally suitable and valuable with butter-milk.

In the north of Ireland, and south and west of Scotland, many farmers carry on what is known as the "Butter and Sour Milk Trade"—that is, the milk is set straight from the cow in large dishes and allowed to remain until the whole quantity is coagulated with lactic acid, and when fully ripe—showing a fine velvety appearance on the top, with a decided lactic flavour—the whole quantity is churned and the butter taken out, the whole of the by-product being butter-milk; this is the kind of milk run on by bakers as being superior to any other kind. Now there is no reason why the separated milk should not be made to serve the same purpose. In the case of the whole milk, the lactic acid is developed under the most favourable circumstances. The milk is cooled from the cow in order to prevent too rapid a development, and care is taken that the acid does not over-reach its maximum and produce rancidity; at the same time the error of ripening too slowly and producing bitterness has to be avoided in order to produce good butter, and the result is good butter and good butter-milk at the same time. Now, if those who handle separated milk for baking purposes would cool it down from

Illus. 44. SHORTHORN COW, "MISS BELLA DRUM, VI."

(1st Prize R.A.S.E. Show, Maidstone, 1899. Property of Miss Alice D. Rothschild, Waddesdon Manor.)

separating temperature to 65 deg. and add a starter of lactic ferment, set it aside undisturbed in a dry even temperature, say about 60 deg., the whole body of the milk will be ready for churning in 48 hours. Ten minutes churning will be sufficient to break up the coagulation; care should be taken that this class of milk is not subjected to any process of heating after being churned, otherwise decomposition will at once set in, and the milk become unfit for baking.

Butter-milk from cream or whole milk, will contain a percentage of butter fat, that is not to be found in separated milk. On the one hand the dairyman is the loser by selling his butter in the butter-milk, and on the other, the baker can add a cheaper fat and serve his purpose equally as well with ripened (soured) separated milk. We feel confident that if the ripening of separated milk were more scientifically attended to, that millions of gallons more would be required yearly in Great Britain for baking purposes than there is at present.

Biscuit factories are now fully alive to the value of separated milk—nothing cheaper can be found to enhance the quality and value of their goods. Those firms who have been hanging back and grudging the cost of the milk and baking with water have almost lost their trade. Take such firms as McVitie and Price, in Edinburgh. Their milk-receiving department is like a huge creamery, and the demand for their biscuits and cakes all over the world is something marvellous.

In the making of ice-cream separated milk is very useful when taken straight from the separator.

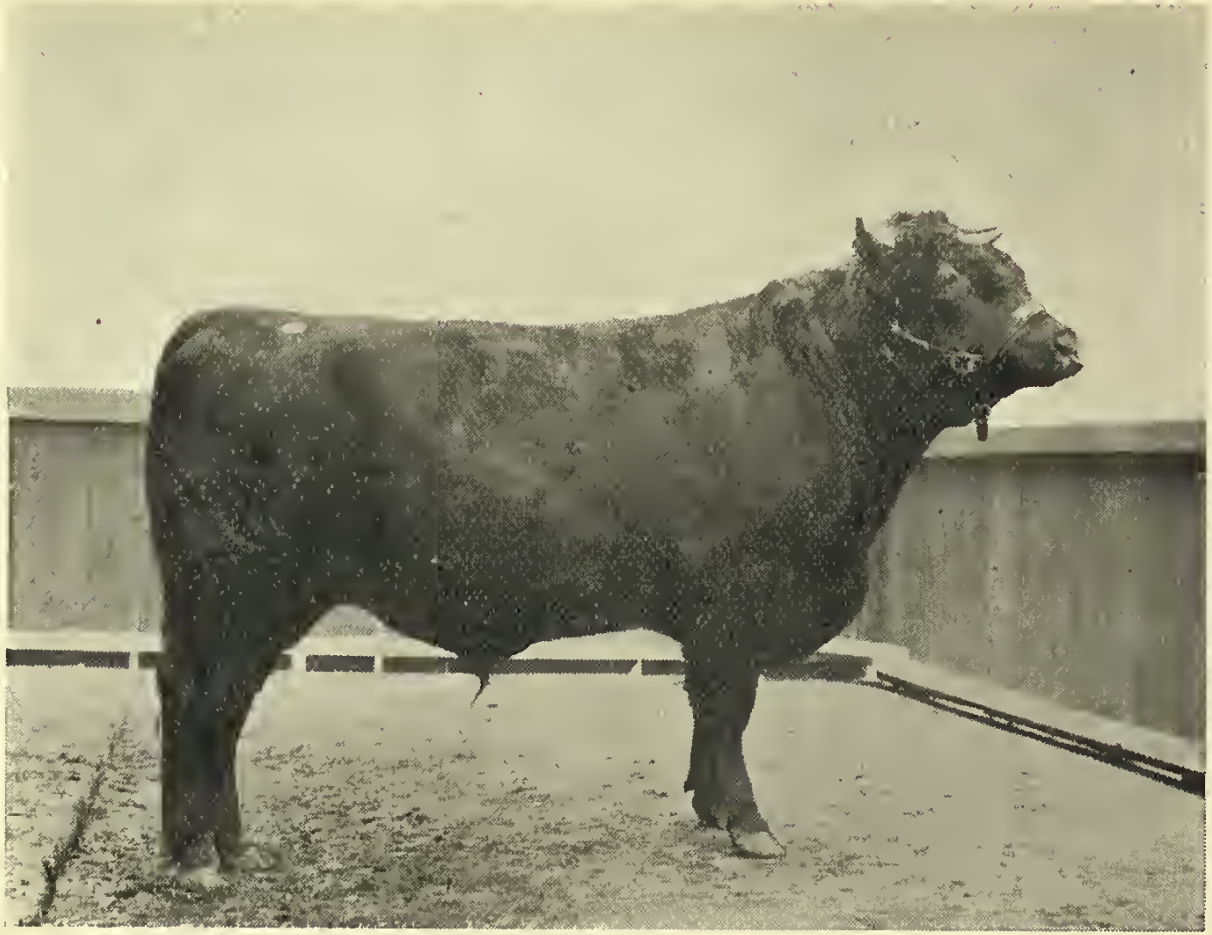
In the baking of cakes more milk and fewer eggs is now the rule. Cakes that used to be made with a mixing of 24 eggs and no milk are now made with 16 eggs and a quart of milk, producing a cheaper and richer cake.

French scalded pastry, Russian toffies, and all the finest confections, where liquid can be used in their manufacture, are

much improved with milk. French, German and Italian pastry, cherry, fig and Genoa cakes can all be made with milk.

In the preparation of soups, such as white soup, potato, fish, celery, tomato, green pea, or green corn soups, separated milk will be equally as serviceable as whole milk.

The future extension of the use of milk, and especially separated milk, in the baking and confectionery trades, largely depends on the creamery managers presenting it in a condition suitable for the trade. Those who use it with barm or yeast must have it perfectly free from lactic acid, and this requires care in separating, scalding, refrigerating and delivery. Those who use it as sour milk must have it ripened under the most favourable circumstances, free from rancidity or bitterness, or any mixture of water or collection of old milks that have been souring under different conditions for days, and, in several cases, a week.



Illus. 45 SHORTHORN BULL, "DUKE OF BARRINGTON."

CHAPTER XII.

USEFUL INFORMATION FOR DAIRY PUPILS.

ANALYSES OF DAIRY PRODUCTS.

New Milk.		Separated Milk.	
Water	87%	Water	90%
Fat	3·5%	Casein	4%
Casein	4%	Fat	0·1%
Albumin	0·5%	Ash	0·70%
Milk Sugar	4·25%	Sugar	5·20%
Ash	0·75%		

Cream for Churning.		Thick Cream.	
Water	67·37%	Water	44·18%
Fat	25%	Fat	52·00%
Casein	4%	Casein	2%
Sugar	3%	Sugar	1·50%
Ash	0·63%	Ash	0·32%

Butter Milk.		Whey.	
Water	91.5%	Water	93·15%
Fat	0·30%	Sugar & Lactic Acid	4·90%
Casein	3.5%	Fat	0·30%
Sugar	4%	Ash	0·70%
Ash	0.7%	Nitrogenous Matter	0·95%

SPECIFIC GRAVITIES.

Water	1·000%	Butter	0·912%
New Milk	1·030%	Ether	0·730%
Cream	0·985%	Alcohol	0·820%
Skimmed Milk	1·038%	Sulphuric Acid	1·830%
Butter Milk	1·025%	Margarine	0·901%
Whey	1·027%		

BUTTER

Is made up of the following fats in combination with glycerine :—

Myristine.	Stearine.
Palmitine.	Butyrine.

BOILING POINTS.

Water	212 Fahr.	Oil of Turpentine	316 Fahr.
Milk	212 „	Sulphuric Acid	620 „
Ether	96 „	Mercury	662 „
Alcohol	176 „		

DIFFERENT TEMPERATURES FOR THE TREATMENT OF MILK.

Milk is taken from the cow at a temperature of 95 to 98 deg. Fahr.

Milk is separated at 88 deg. to 90 deg.

Cream is churned in summer at 56 deg. to 58 deg.

Do. do. winter at 60 deg. to 62 deg.

Rennet is added to milk for cheese-making at 85 deg.

Scalding for cheddar cheese, 100 deg.

Pressing curd, 75 deg.

Ordinary scalding of milk, 160 deg.

"Pasteurising" of milk, 184 deg.

Sterilising of milk, 212 deg.

Illus. 46. SHORTHORN TWO-YEAR-OLD BULL, "PRIDE OF COLLVINE."

MILKING.

A fair milker will milk 8 average cows per hour; vigorous milking is the most profitable for all concerned. The cow likes a rapid milker and offers no resistance, whereas she is unwilling to give to a slow milker. In ordinary cases twice a day is sufficient for milking cows and generally most convenient. There are two systems of hand milking—the one with dry, and the other with wet hands. The system of dipping the hands into the milk to keep them wet is very objectionable, and the reason is obvious.

The strippings are the last portion of the milk taken from the cow, and contain on an average twice the quantity of butter fat that is in the first half, and this should be done by a special milker going round all the cows at every milking.

Mechanical milking machines are making little progress considering the time they have been in existence, and the growing need there is for them. The only milking machines we know of are "The Lawrence and Kennedy"—a pulsating, and the "Murchland"—a continuous suction machine. We have never been able to see any advantage of the pulsating movement; it is suction that is required, and if the human hand could manage it, the cow would readily give a continuous flow, and a break is rather a hindrance than a help to the milking.

MEANING OF TECHNICAL WORDS IN CONNECTION WITH DAIRY PRODUCTS.

Fat in milk.—Butter fat.

Casein in milk.—The nitrogenous matter coagulable by rennet or acids.

Albumin in milk.—The nitrogenous matter coagulable by heat.

Lactose.—The sugar in milk.

Protein.—The total nitrogenous matter in milk.

Curd.—The casein in concrete form.

Sterilised milk.—Free from all germs and hermetically sealed.

"*Pasteurised*" *milk.*—That which has been heated above the death point of fermentive organisms, but below the coagulating point of the albumin.

Natural starters.—Sour milk, butter milk, or whey.

Starter.—A culture of any nature producing fermentation.

Pure culture.—A single organism.

A pure culture starter.—Made by introducing a pure culture into sterilised milk.

Colostrum.—The first milk given by a cow after calving.

SANITARY RULES FOR DAIRIES.

1. The cows from which the milk is obtained should be perfectly healthy, and quite free from any affection of the udder. Each cow's udder should invariably be washed before milking.

2. The cows should be well fed and properly lodged. The trough mangers so constructed as to be easily and thoroughly cleaned whenever required; the water supply for the cows should be pure and wholesome; where brewers' grains are used, they should be stored in outside receptacles that can be easily and quickly cleaned.

3. The byre should be well lighted and ventilated; the floor constructed of non-absorbent materials, and channelled in such a manner as to enable it to be kept dry and clean. The byre should not be used to house or feed any other animals, or for poultry; the ceiling or inner surface of the roof, and the walls should be washed with quick-lime every three months. No

water-closets, privy, cesspool, urinal, or dung pit should be in the byre, or have any direct communication with it.

4. The manure should be removed twice daily to a place outside the byre, and sufficiently far from it to prevent any contamination of the byre or milk.

5. Neither full nor empty cans should be allowed on any account to remain near a drain, privy, or dung heap, or any other collection of refuse. All the cans and vessels used in the dairy should be scalded and thoroughly cleansed before being used. No cans should be used that have cracks in the body or lid, where the stale milk becomes secreted.

6. The dairy or room used for measuring or storing the milk should be well ventilated, and so paved as to allow a fall or slope towards an opening in the wall leaning to a gully-hole outside, and such gully-hole should be properly trapped. The water supply should be pure and wholesome, having no contamination from any drain, privy, or manure heap.

7. The milker's hands and arms should be washed every time without fail before they are allowed to touch the cow's udders, and each milker should be provided with a stool. The milkers, dairymaids, or any one handling or coming near the milk or cans should be scrupulously clean in their persons, and perfectly free from skin or any other disease. No person suffering or recently recovered from infectious disease should be allowed to come near the cow byres, or dairy, or to assist in any operations connected with the cows or milk.

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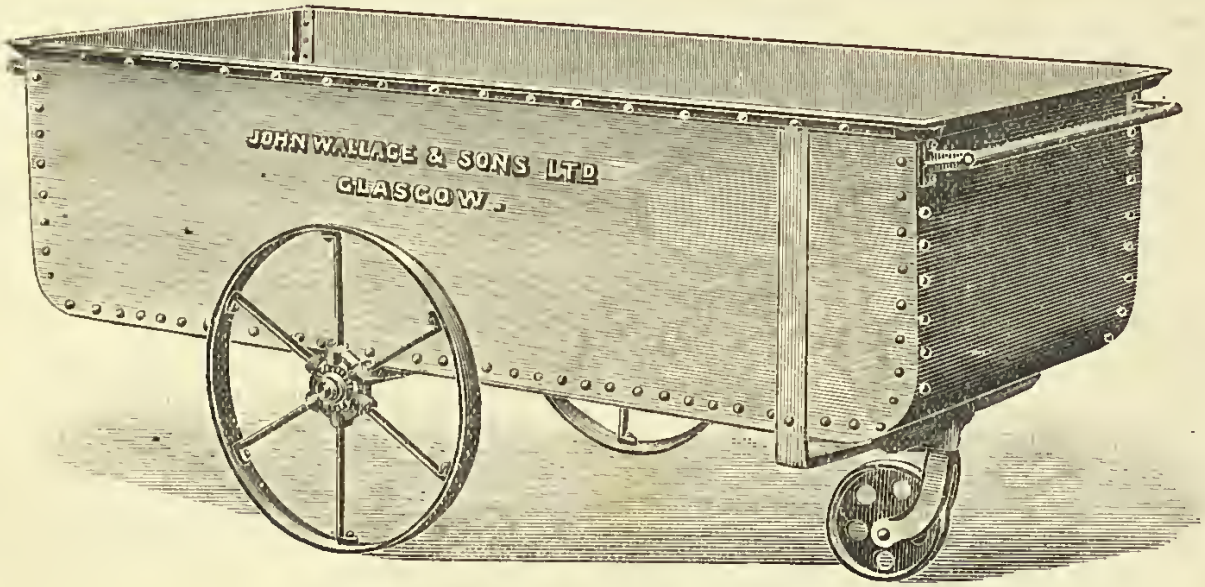

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